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ELECTRICAL WORLD AND ENGINEER.

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NATIONAL ELECTRIC LIGHT ASSOCIATION.

All the signs indicate that the convention of the National Electric Light Association in Boston next week will be one of the largest and most important ever held by that body. The engagement of rooms in advance—far exceeding any precedent—shows that the attendance will be very good, while the programme, which we present on another page, is evidence that there will be an abundance of live material for discussion. We give also a little sketch, which, we believe, will be of interest in a retrospective way, of the last convention held by the Association in Boston seventeen years ago. The programme then was indeed meagre as compared with the imposing list of papers, subjects and authors submitted by President Edgar for the coming week. But the same continuing spirit and policy have run through the history of the Association, and its evolution has been marked by steady good work. A few years ago it looked as though the Association had outlived its earlier usefulness, or at least had fallen upon days of restricted opportunity; but it is now easily to be seen by everybody that the responsibilities and duties of the Association to the electric light and power industry are larger than they ever were, and are being met in a manner to command respect and to ensure its growth.

MEETING OF THE INSTITUTE.

During the current week the American Institute of Electrical Engineers has held its annual meeting in New York City. The statement of the directors as to the affairs of the Institute is a highly creditable one, and to all who take interest in the Institute and in the advance of the profession, it must be encouraging to note that with the present month the membership has reached the remarkable figure of 3,000 with an immediately prospective total of 3,300. This rate of growth, of 800 or 900 new members a year, speaks volumes for the expansion of the profession and its allied arts, and shows that the Institute, on thoroughly equal terms, can hold its own with the other great national engineering societies, among which it is the latest comer. The financial affairs of the Institute are also in excellent condition in spite of heavy expenses assumed during the past year or two, while it is also a splendid proof of public spirit to find that the building fund for the Institute's share in the Union Engineering Building project has already been lifted over $60,000 by the contribution of members. The officers who have been elected to the Council are in themselves a pledge that the good work will go on. The new President, Mr. John W. Lieb, is representative of the highest type of electrical engineer and of all the noblest aims and aspirations of the Institute. He is a hard worker and a man of affairs and of culture, and one whose occupancy of the chair coincides happily with the year of the Congress and the visit of so many electrical friends from abroad.

NEW RESOURCES OF ILLUMINATION.

Whatever may be their final outcome, it is interesting to note that in our present issue, three of the newer electrical illuminants are treated under aspects which warrant a very hopeful feeling in regard to them as permanent and valuable additions to the resources of the electric lighting art. In fact, the details given with regard to the adoption of the Nernst lamp for the art galleries at the St. Louis Exposition; and concerning the successful employment of mercury vapor lamps in the largest automobile garage in the country, indicate that both of these forms of lamp are finding quickly spheres of utility and fitting into them. We must all welcome heartily

such additions to the means belonging to the art, especially as the whole work and utility of illumination is thereby enlarged. As a general thing we have of late been slower or more timid than European engineers in taking up and fostering these new developments, so that even to-day some varieties of illuminants are in use across the Atlantic which have virtually never been seen here. Even if they are no good, our famous American curiosity and inquisitiveness ought at least to have brought them forward, so that judgment could be formed in regard to them from actual observation.

The third novelty, if we may so describe it, though it has less present actuality than the other two lamps to which our pages draw special attention, is the magnetite lamp. Mr. Charles P. Steinmetz describes this in a characteristic article, which we know will be read with great eagerness. Rumors and reports in regard to this new illuminant have been in circulation for some time past, and Mr. Steinmetz now to some extent gratifies the general desire for information of the subject, supplementing his text with some illustrations of the lamp and its arc. It is to be hoped that the new lamp will be on view in Boston next week, and if so, it will certainly constitute one of the leading novelties of the convention.

The Electrical Hub.

From the standpoint of the central station man the electrical situation in Boston is a most instructive one in many respects. If one were to pick out the features which seem most important to the engineer, the two most conspicuous would be the respective policies of the Boston Edison Company and the Boston Elevated Railway Company in the building up of their distribution systems. The former is an admirable evidence of the progressive instincts of the talented engineer who is the head of the system. The problem which he had to solve was the welding into a coherent whole not only of two diverse urban systems of distribution, but of a group of suburban stations of most heterogeneous character. The task with all its inherent difficulties has been accomplished in a most workmanlike fashion. From the great alternating central station energy is being transmitted more than thirty miles to suburban customers, while the direct-current urban service has been preserved in its integrity, and the improvement in service all over the territory served has been very marked. It is a remarkable example of deft adaptation in a rather trying combination of conditions. The other is the very striking and successful policy of segregated stations of the Elevated Company. The feeding of so great a network from a skillfully planned group of allied stations stands alone in American central station working. In almost every instance this condition has been met elsewhere by generation of power at a single central station and distribution at high tension to sub-stations. We should much like to see a disclosure on the matter of cost of power as between the Boston system and those operated with converter sub-stations. From what data is available on the subject, we are inclined to the opinion that the Boston stations would not come out second best. The sub-stations certainly produce power within a very small percentage of the figure reached by the large new station, and the latter will compare favorably with the best figures reached elsewhere.

Measurement of the Insulation Resistance of an Electric Wiring System.

There is very little trouble in measuring the insulation of an electric plant or wiring system when the plant has been shut down. The system is then an inert network of conductors. But when the plant is at work, or in popular language "alive," the measurement is neither so easy nor so convenient. The difference brings to mind the relative degrees of convenience in measuring the span of an eagle's wings dead and alive. The article of Mr. E. F. Northrup on page 966 relates to the methods of insulation measurement in a working system. These methods are not entirely new, but they are well presented and are set in very practical form. Two methods are described. In the first the source of testing e.m.f. is the generator or set of generators working in the system. A reading of potential to ground from each side of the system through a voltmeter of known resistance, together with the magnitude of the working voltage, suffices to determine the apparent insulation of the system on each side. In the second method, which is better adapted to relatively high insulations, a separate testing e.m.f. is used independently of the working e.m.f. in the system, and the testing e.m.f. is applied to the system at a point such that no appreciable disturbance is effected. The latter method is capable of being employed with a three-wire system, or with a system of any number of wires; but the former method requires some modification to meet the requirements of a working three-wire system.

The Protection of Telephone or Telegraph Lines When in Hazardous Proximity to High Tension Lines.

The article on this subject, by Mr. R. E. Chetwood, Jr., appearing on page 968 of this issue, is of much interest as representing the most modern practice of the Bell Telephone system. The engineering department of that company has faced the problem under consideration for a number of years, and has had a very wide experience in the nature and conditions of the hazards to which overhead telephone wires are exposed by crossing the route of high-pressure wires. The importance of adequate protection from high-tension crosses is manifest after a moment's consideration. If a high-tension line carrying power electrically at a pressure of many kilovolts crosses the route of a telephone pole line, the high-pressure wires must cross either above or below. It is desirable that they should cross above the telephone lines, because the high-pressure wires, being usually much the stouter, are less likely to break accidentally. Nevertheless, there is always the remote possibility of an insulator breaking on one of the poles of the cross-over, thereby bringing much electric pressure on the cross arm, which might burn off and let the high-pressure wire fall upon the telephone wires below. If, on the other hand, the telephone wires cross above, their number may be considerable, say, 30 or 40, and at some time one of these wires may break in the cross-over span, thereby falling on the high-pressure wires below.

In either case the contact between high-pressure wire and telephone wire may be fraught with disastrous consequences. The best result that can be looked for is the rupture of the small telephone wire, at or near the point of contact, whereby the high-pressure connection immediately ceases. If the telephone wires does not break, the high pressure of the transmission wire is led into the telephone central station at one end, and into the telephone subscriber's premises at the other. In each of these places it is the unvarying custom to install protective devices, which are designed either to open or ground the circuit, and to remove the pressure from the terminal apparatus. There is, however, always the remote possibility of something going wrong at a protective device, whereby it may fail to operate. In such a case the high pressure on the telephone line might destroy apparatus at either end, and, under particular conditions, might initiate a fire. It is physically possible for a cross between a telegraph or telephone line and a high-tension line to initiate a fire in a building a hundred miles away from the cross, the high-pressure being capable of carrying a dangerously strong current to similar distances.

Moreover, every year sees more wires strung across the country, more telephone and telegraph wires, and more high-pressure transmission wires. This is only another way of saying that civilization and material wealth are advancing. Nevertheless, there is no cause for undue apprehension merely because the network of line cross-

ings is increasing in complexity. We all know that the staunchest steamer ever built may founder if she collides in midocean with another vessel. The chance for collision undoubtedly increases with the number of ships along the course, and more ships are sent to sea from year to year. The greater the speed of a vessel, other things being equal, the greater the chance of a collision, yet although ocean speeds are increasing, we do not hesitate to embark on a voyage to Europe whenever opportunity smiles upon occasion. The correct course, therefore, is neither to ignore the dangers of high-tension crosses on the one hand, nor to take unreasonable alarm on the other; but to provide against accidents by engineering methods. Since engineering brings about the danger, engineering is able to minimize it. Every step taken from barbarism towards civilization entails some penalty of danger. Tall buildings may totter and fall in an earthquake. Railway trains may be wrecked. Illuminating gas supply may give rise to explosions in buildings. Yet none of these things cause us dismay. We face them confidently with engineering methods.

Mr. Chetwood's article sets forth methods of cross-over construction which are designed to reduce the possibility of accidental crosses to a minimum. The preferred construction is a short cross-over span, with the high-pressure wires above, on double insulators, but not dead-ended. The insulators have steel pins which are grounded. If this plan is impracticable, the telephone wires go over on a short span. Where short spans cannot be used, guard wire spans are introduced. The interesting feature of the high-tension guard wires is that when grounded they must be capable of carrying three times the normal high-tension line current. The real difficulty in many cases is to make an effective ground. The method described is probably the most satisfactory known under the conditions of practical line construction. It consists in employing a galvanized-iron rope and burying a coil of half a dozen turns, not less than eighteen inches in diameter, at the depth of permanently moist earth, in three bushels of fine coke. The general features of the cross-over construction described seem to be well worthy of imitation, which in such cases is known to be the sincerest form of flattery.

ELECTRIC FIRE RISKS.

The last quarterly report from the electrical bureau of the National Board of Fire Underwriters is just at hand, and like its predecessors it contains much that is instructive. The good old times when every fire of unknown origin was charged up to electric circuits have gone by, but the habit of years is hard to break, and we are not surprised to see the report of 181 fires "supposed to be due to electricity." To do the board credit, these fires are not included in its report as electrical, but the average fire chief or inspector greatly dislikes having to report a fire as of unknown origin and evidently soothes his soul by accusing the almost omnipresent electric wire. Fifty other fires charged to electricity proved to be due to quite prosaic causes like overheated stoves, matches and cigar stubs. However, the accredited list shows 135 fires definitely traced to electrical causes; and while this is not a large number considering the almost universal presence of electrical circuits in American cities, it is great enough to bear considerable reduction. From the standpoint of the electrician it is gratifying to note the comparatively small proportion of the total fires due to actual bad construction on the part of the electric light circuits. By far the largest proportion of the fires were caused by the hopeless and irremediable foolishness on the part of the users of electric current. A smaller but still conspicuous proportion was caused by crossing of telegraph or telephone wires with electric light wires. We would much like to know what number of these, if any, came from the fault of the latter. It almost seems as if bad construction were at a premium on these slightly constructed circuits, for their wires seem to break and fall upon the heavier wires beneath on the smallest provocation.

But the plain everyday fool seems to have been the active agency in most of the cases adduced. We should have supposed, for instance, that at this date people of the most ordinary intelligence would have awakened to the fact that incandescent lamps if placed in a confined space in contact with inflamable material are unsafe. But each report brings the same old tale of woe. Even the incandescent lamp as a foot warmer on cold nights comes to the front with each succeeding winter, and each holiday season brings back the fine old sure-fire combination of lamp-bulb and cotton waste. One would suppose, too, that people would have learned to be careful about driving nails through electrical conduits, mixing up electric wires and gas pipes, replacing fuses by copper wire, and all that sort of thing, but they seem to go on in the same old way. Misused flexible cords seem to be responsible for frequent difficulties. But there are still left, after eliminating the fool, a moderate proportion of fires due to bad or stupid house wiring. The old open link cut-out scores quite too frequently. In these days it surely should be replaced by something better, or at least placed where it can do no harm. Even relatively poor material can do good service if it is used discreetly, while the very best can be made dangerous by misuse. When one couples poor material and bad judgment, the combination is invincible. We often wish that the Board of Fire Underwriters would use its power less in general recommendations than in seeing that specific ones are honestly carried out. The modern American frame house is more or less of a fire trap at best, and when built on speculation by an avaricious and unscrupulous contractor, it becomes a menace to public safety.

Every insurance inspector can enumerate a long list of atrocious violations of all rules of decent construction by thievish wiring contractors, and denounces them with hearty indignation in which we earnestly join. There is in these days absolutely no excuse for dangerously bad interior wiring such as is continually being discovered, often, alas, too late. The Board of Fire Underwriters can do more to prevent this than any other power, and in a campaign for good work it will have the cordial support of the electrical public at large, and the support, too, of every honest electrical contractor. For the honest man who insists on doing only good and thorough work is continually robbed of business by the chap who scamps his materials and leaves his work half done. We have personally seen scores of houses being wired in a way that simply courts danger from fire, both as regards material and method of installation. Some of the jobs met the letter of the law; none of them would have passed an honest inspector with any discretionary powers. The bad work of last year and the year before insures fire risks this year and next, and we would like to see opened a campaign of education and rigid inspection for the enforcement of safe installation. The stake is a large one; even though electrical fires have been greatly reduced in number of late years the aggregate annual loss to the insurance companies from this cause would pay for the services of a tremendous force of competent inspectors. Each contractor rigorously brought to book is less dangerous for the future, and by the same token the public is safer. We think the board has erred in the past in trying to do too much in general and too little in detail; in making sometimes hypercritical distinctions in its approved materials of construction, and paying too little attention to the manner of their use in concrete cases. It is quite possible to do a "cheap and nasty" job of wiring with approved material and still follow the letter of the code, and the fellow who does this generally is able to work off poor material to boot.

Programme of the National Electric Light Convention.

The following is the detailed programme of the proceedings of the National Electric Light Association meeting to be held at the Hotel Vendome, Boston, next week. It will be the twenty-seventh convention:

Tuesday, May 24, First Session, 10 o'clock A.M., Convention Hall, Hotel Vendome.—President's address, Mr. Charles L. Edgar, Boston; report of Committee on Progress, Editor Mr. T. Commerford Martin, New York; "A Three-Wire, 500-Volt Lighting System," Walter I. Barnes, Providence; "Luminous or Flaming Arc," Mr. Welles E. Holmes, Newton; Committee on Standard Candle-Power Incandescent Lamps, Dr. Louis Bell, Boston, chairman; Committee on Legislative Policy, Mr. Samuel Insull, Chicago, chairman; Committee on Photometric Values of Arc Lamps, Mr. Henry L. Doherty, Denver, chairman; Committee on Uniform Accounting, Mr. Guy L. Tripp, Boston, chairman.

Tuesday, Second Session, 2 o'clock P.M.—"A One-Hundred-Mile Transmission Line," Mr. Robert Howes, Spokane, Wash.; "Grounding the Neutral of High-Voltage Generators," Mr. George H. Eastman, Chicago; "Remote Control of Electrical Apparatus," Mr. William H. Cole, Newton; "The Organization and Equipment of an Arc Lamp Department," Samuel G. Rhodes, New York; "Electric Heating," Mr. James I. Ayer, Cambridge; report: Lost and Unaccounted-for Current, Mr. C. W. Humphrey, Denver.

Wednesday, May 25, Third Session, 10 o'clock A.M.—"Economy in Minor Station Supplies." Mr. Edgar B. Greene, Altoona, Pa.; "Notes on the Internal Combustion Engine as Applied to Central Station Service," Mr. E. E. Arnold, Pittsburg, Pa.; "Economy Test of a 5,500-hp Three-Cylinder, Compound Engine and Generator.," Messrs. J. D. Andrew and W. F. Wells, New York; "The Mechanical Stoker and Human Operator," Mr. Edwin Yawger, Pittsburg; Committee on Award of Doherty Gold Medal, Dr. Schuyler S. Wheeler, Ampere, N. J., chairman; report: Investigation of Steam Turbines, Mr. W. C. L. Eglin, Philadelphia, chairman; "Practical Notes on Steam Turbine," Mr. Francis Hodgkinson, Pittsburg, Pa.

Thursday, May 26, Fourth Session, 10 o'clock A.M.—"Electric Light and Power Plants in Connection with Ice Plants," C. L. Wakefield, Dallas, Tex.; report on Sign and Decorative Lighting, Arthur Williams, New York; report on Advertising, La Rue Vredenburgh, Boston; report on Purchased Electric Power in Factories, W. H. Atkins, Boston, chairman; report of Committee on District Heating, E. F. McCabe, Lewistown, Pa., chairman; report on Office Methods and Accounting, Frank W. Frueauff, Denver.

Thursday, Fifth Session, 2 o'clock P.M.—"A Proposed System of Standard Instruments for Operating Companies," H. P. Davis, Pittsburg, Pa.; "Single-Phase Power Motors for Electric Lighting Stations," W. A. Layman; report on Analysis of Flue Gases, Henry L. Doherty, Denver, chairman; "Wrinkles," Editor Charles H. Williams, Madison, Wis.; "Question Box," Editor H. T. Hartman, Philadelphia, Pa.

Thursday, Sixth Session, 8 o'clock P.M.—"Types of Large Water Power Installations," with stereopticon, Dr. F. A. C. Perrine, Pittsfield. Executive Session.

An excellent programme of trips and entertainments has been provided, note of which has already been made and which will be carefully arranged in detail. The chairman of this committee is Mr. J. I. Ayer, and the members are: Prof. C. A. Adams, Albert Anderson, William H. Atkins, F. E. Barker, F. P. Barnes, R. N. C. Barnes, George H. Berg, H. Bottomley, Capt. William Brophy, F. E. Cabot, C. W. Cartwright, A. E. Childs, A. T. Clark, Prof. H. E. Clifford, S. B. Condit, Jr., Charles B. Davis, R. B. Edes, George C. Ewing, H. H. Fairbanks, H. C. Farnsworth, George H. Finn, Almon Foster, W. C. Fish, H. A. Hale, Charles J. Hatch, Percy Hodges, W. E. Holmes, C. W. Holtzer, Sydney Hosmer, P. J. Kennedy, A. H. Kimball, George B. Lauder, F. W. Lord, Emil O. Lundin, Norman Marshall, E. H. Mather, Everett Morss, H. W. Moses, W. L. Mulligan, J. H. Parker, H. S. Potter, C. B. Price, C. F. Prichard, Andrew Raeburn, F. H. Raymond, F. S. Richardson, Frank Ridlon, D. P. Robinson, F. P. Royce, G. L. Sadler, F. S. V. Sias, F. E. Smith, Prof. H. B. Smith, J. A. Smith, J. Brodie Smith, George B. Stetson, F. J. Stone, G. M. Stuart, La Rue Vredenburgh, Thomas C. Wales, R. L. Warner, N. T. Wilcox, S. B. Wetherbee, F. S. Wilson, Paul Winsor, W. C. Woodward.

The Executive Committee of the Association will hold a meeting on Monday evening. The members are: Louis A. Ferguson, Harry Bottomley, Alex. Dow, A. C. Dunham, J. H. Perkins, C. F. Hewitt, D. P. Robinson, P. G. Gossler, H. T. Hartman. The officers of the Association are: C. L. Edgar, president; S. B. Livermore, first vice-president; J. W. Lieb, Jr., second vice-president; E. H. Davis, secretary and treasurer; Harriet Billings, assistant secretary; George F. Porter, master of transportation. The usual fare and a third applies on all trips to the convention. The Southwestern Excursion Bureau has granted a rate of a fare and one-third on the certificate plan from all points in its territory to Boston and return to delegates and friends attending the twenty-seventh convention. This is the first time the concession has been made in this territory, and is additional evidence of the geographical as well as numerical growth in membershhip. The reduced rate has now been granted by all the passenger associations, and if the applications already received for rooms at the Boston hotels are any indication, the rate will be very generally taken advantage of.

Tesla on the Patent Office.

The New York *Sun* of Wednesday contained a letter from Mr. Nikola Tesla in which, referring apparently to recent publications concerning difficulties between Edison and the Patent Office, he takes up the cudgels for the office and is particularly complimentary in references to its technical staff. In a long personal experience he said he has found the examiners to be far more satisfactory than he had thought possible, and many times he has noted with astonishment the thorough grasp of ideas, the keenness of the criticisms and the exhaustiveness of the search for anticipations, while invariably he has obtained valuable information through the references cited and the suggestions made. He considers any criticism capable of creating a doubt in the minds of people as to the faithful performance of duties and competency of its staff must be deemed unfortunate, since such doubt may destroy confidence in the value of patent property. Mr. Tesla advocates more liberal appropriations and more suitable quarters for the Patent Office, and refers to the fact that owing to low salaries difficulty is found in retaining the services of competent men.

While examiners, he says, can never keep quite abreast with inventors, they are men well educated and trained, recruited from colleges, and to obtain appointment have to pass a severe examination covering the several branches of applied and cognate sciences. Serious dissatisfaction then is not likely to arise from the examiners' insufficient knowledge or lack of comprehension, nor is it apt to come from an inherent defect of adopted procedures, although some of these might be omitted to advantage. For example, the suggestion of claims by the examiner in a case of conflicting applications is, in my opinion, always in favor of the inventor possessed of better knowledge and stronger imagination. The introduction of greater rigidity in the withdrawal and amendment of specifications might also be helpful. But, after all, what difference does it make how the original documents are modified? The successive changes are all recorded and can be examined at any time. If new matter is injected in an amended application it will not be permitted to remain, and, ultimately, the testimony in the interference will bring out the exact facts which will settle the question of priority. The advantages which might be secured by such or similar changes would be slight. Of late years the demand on certain departments has been increasing so fast that more expeditious methods had to be adopted; and this has naturally detracted from the quality of the work. The remedy for this is a liberal appropriation.

Mr. Tesla considers that one of the greatest problems confronting the world is to devise methods and means for protecting intellectual property. "As we develop, this need asserts itself more and more. The ultimate aim should be to arrive at laws and regulations at least as precise as those which define the ownership of tangible things. A new principle is still to be discovered which will make this possible. Perhaps in the distant future photographic records of the retina of the eye may furnish a foundation for a new and more perfect system of protection and just valuation of the creations of the mind. As far as I am able to understand the working of the human mechanism, such records offer the only chance of doing away with the present imperfect ideas of possession and use of crude equivalents. But let us bear in mind that for the time being the United States Patent Office is the farthest advance toward that ultimate aim. Taking this broader view of the institution we shall better appreciate its immense influence on the welfare and morals of the country."

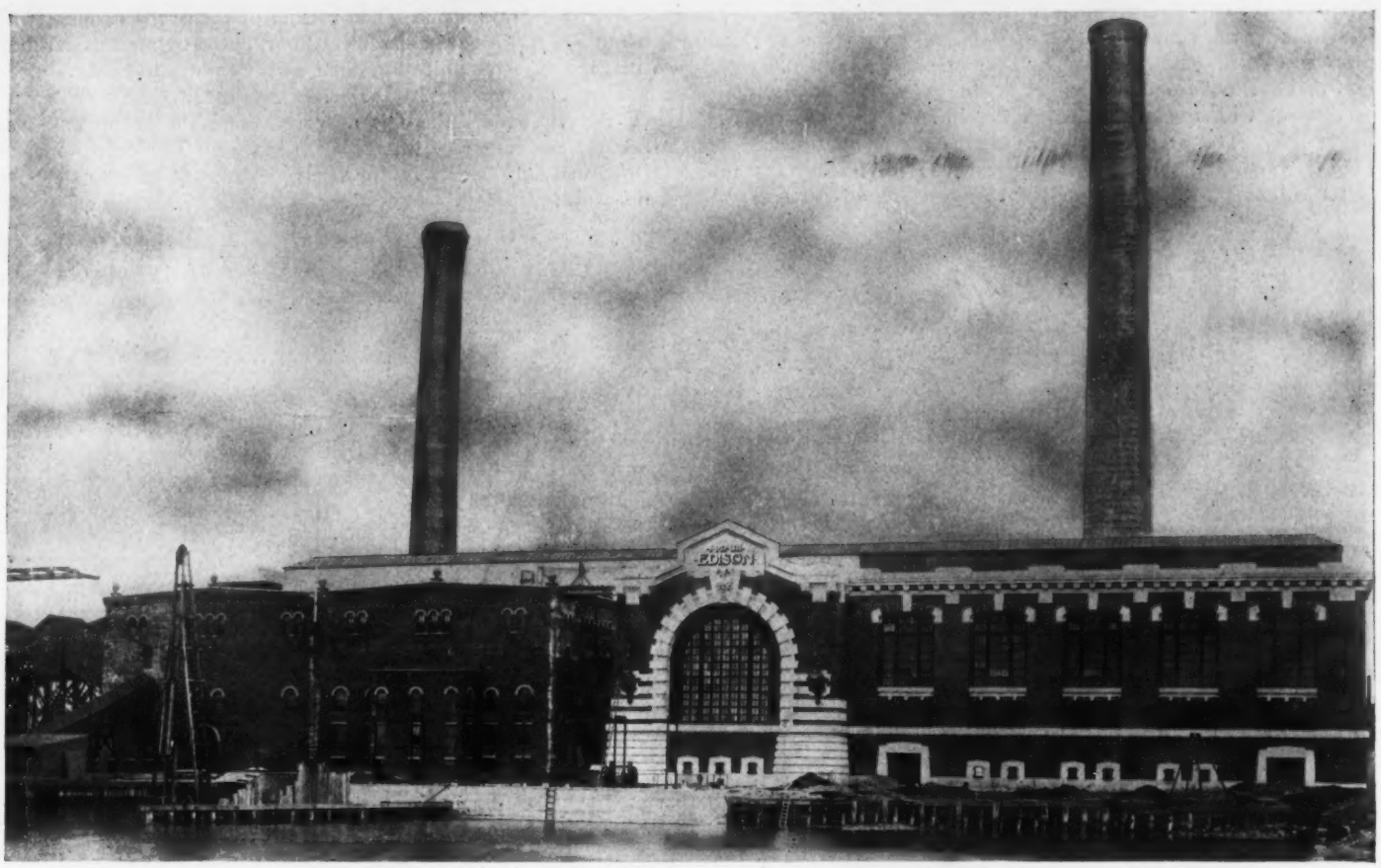


FIG. 1.—VIEW OF BOSTON EDISON STATION FROM THE HARBOR.

Expansion of the Boston Edison System.

SIXTY thousand kilowatts is to be the ultimate generator capacity of a steam turbine station that is being constructed by the Edison Electric Illuminating Company in Boston. The site of this new station is a plot of land 810 ft. by 1,300 ft., bounded on three of its sides by L Street and East First Street, South Boston, and by the Harbor Commissioners' line. A portion of this plot, perhaps one-third, is now under tide water, and is occupied in part by the coal wharf and the docks of the company. On the dry portion of this area, and not far from its center, is the old Fourth or L Street generating station of the Edison Company, which was built by the Boston Electric Light Company in 1898, and passed to the Edison Company with the purchase of the entire Boston electric system in 1901. An elaborate 26-page article on the then existing Boston system, by Mr. E. S. Mansfield appeared in ELECTRICAL WORLD AND ENGINEER in May of that year.

The new turbine station adjoins the generator room of the original plant, fronts Boston Harbor at a distance of about 128 ft. from the water line at the present bulkhead, and is designed to extend back, ultimately to the East First Street line of the property. In plan the new station is, with small exceptions, at its front end, a rectangle of about 252 ft. parallel with East First Street, and about 638 ft. parallel with L, and with the longer side of the old plant.

The ground area represented by these figures is that of the proposed station when fully completed, but at present only the front or harbor end of the station is being built. The length of this portion parallel with L Street is about 230 ft. in its largest part. On the ground where parts of the propsed station will set there are now located several old buildings that will in the future be removed. In general elevation the new station has one high story, but this is varied by a basement under the boiler room, and by dividing the switch house into three low stories with a basement underneath. In general structure the new station is built entirely of concrete, brick, stone, tile and steel from foundation to roof. The main walls of the station, both exterior and interior, are of brick, and the exterior walls, especially on the harbor front, have heavy stone trimmings that give a decidedly ornamental effect. At the harbor end of the turbine room, which juts out a little beyond the boiler room, there is a great arched window whose keystone bears a figure of Mercury, and just above this figure comes the word Edison beneath the letters MCMIII. At either side of this window is a great metal globe in which an arc lamp will be mounted.

As to its interior the new station is divided into the boiler house, the turbine house and the switch house by heavy brick walls that run parallel with the greater dimension of the building. The boiler house thus formed will have interior floor dimensions of about 146 by 630 ft. In the steam turbine house the width is about 65 ft. and the length 642 ft. The front or harbor end of the section of the station called the switch house is devoted to offices, and back of these offices the space on each floor available for switching purposes measures approximately 28 by 562 ft. This switch house adjoins the generator room of the original L Street station on one side and the new turbine room on the other, and communicates by doors with both.

In the design of the new station the controlling idea has been the division of all apparatus into isolated groups in order to reduce as much as possible the damage and delay that might result from any disaster. The unit of division selected for this grouping is the combined steam turbine and electric generator, and the apparatus connected to this unit is distinct, starting with its boilers and ending with its switches. More than this the elements of each group of switching apparatus are separated, the terminals of the generator cables being located in the basement of the switch house, the bus-bar compartments on the floor above, the high-voltage oil switches on the second floor and the controlling switches on the third floor.

The turbine house when completed is designed to contain twelve generating units each rated at 5,000 kw. These turbo-generators will be arranged in a single row from end to end of the turbine house, so that the center of each is about 11 ft. from the wall that separates the turbine house from the boiler house. In line with each turbine unit, but located on the other side of the wall just mentioned, is the row of eight boilers that supply it with steam, each of which has a nominal rating of 500 hp, or 4,000 hp for the group. Each row of eight boilers is set in four batteries and runs across the smaller floor dimension of the boiler house, so that when completely equipped this house will contain twelve parallel rows of boilers. Each group of eight boilers supplies steam to only a single turbine and its pumps. The rows of boilers are arranged in six pairs, the two rows of each pair being back to back with a chimney between them for their common use.

This chimney sets midway between the ends of the two rows of

boilers, and has two flue openings in its opposite sides. The eight boilers forming the opposite halves of each pair of rows at one end connect with their chimney through a common flue, and the eight boilers that form the opposite halves at the other ends of the same rows connect with the other side of the chimney through another common flue. Tile arches between steel beams form the floor of the boiler room, and this floor is supported by the brick walls and by steel columns that rise from the basement foundations to the fall from the grate above. The bottom of each ash chamber, which is about 8½ ft. above the basement floor, opens by mechanical means so that the ashes may drop by their own weight into either a cart or conveyor underneath. In the basement beneath the rear part of each row of boilers there is a space where the steam and water mains for the boilers of that row are located. The steam pipe from each of the eight boilers in any one row drops at once to this steam main, and this main passes directly through the brick wall that

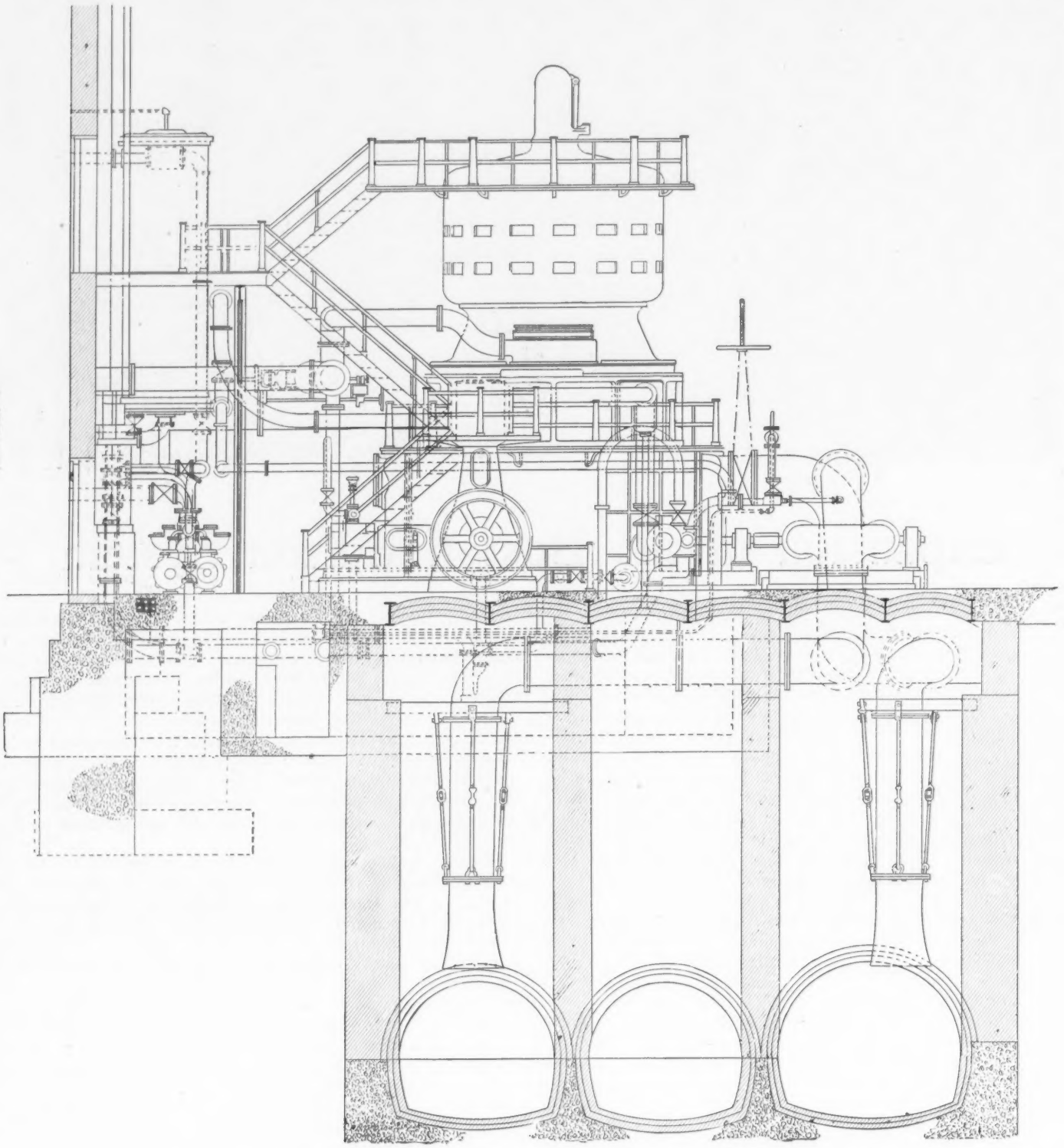


FIG. 2.—ELEVATION OF TURBINE UNIT WITH AUXILIARY APPARATUS COMPLETE.

steel beams that carry the roof. These steel columns are so spaced that each boiler sets between and is supported by two of them at both its back and front ends. In this way six of the steel columns carry each battery of two boilers. Beneath the entire boiler room there is a basement whose concrete floor is just on a level with that of the turbine room, but is 18 ft. below the floor of the boiler room.

Down into this basement beneath each boiler projects a brick, concrete and steel ash chamber, which receives the ashes as they separates the turbine and boiler houses, and to the particular turbine that is in line with this row of boilers.

Above the front side of each row of boilers and extending in part above the roof of the boiler house there is a coal conveyor and bunker of steel, tile and concrete construction, supported on the steel roof beams. The top of this coal bunker is 79 ft. 5 in. above mean low tide water. From this bunker the coal feeds by gravity down to the mechanical stokers in front of the boilers. At the

harbor front of the boiler room light is supplied through a row of large windows in the wall, and beneath each large window there are two small windows and also a door leading onto an iron balcony to enable firemen to get readily to the outside air. Windows and large doors admit air to the basement, and all the air for the boiler furnaces enters in this way and passes up to the fires through openings in the sides of the ash pits. In the long outside wall of the boiler house parallel with L Street there is a large window and there are also two small windows and a door opening onto an iron balcony opposite each aisle between the fronts of rows of boilers. On the roof above each of these aisles there is a monitor skylight.

The concrete floor of the turbine house on a level with that of the boiler house basement, and 16 ft. above mean low tide water, rests on the concrete foundations of the station and has no basement under it. The entire turbine house when completed will be divided by cross brick walls into three rooms of nearly equal length, and each of these rooms will contain four of the turbine units. In each of the brick walls between turbine rooms there will be a great window like that at the outside end on the harbor front, and the end on East First Street will also contain a similar window. Besides these windows there will be a skylight along nearly the entire length of the roof. In the brick walls of the turbine room on its longer sides there are steel columns that run up from the basement foundations and support crane beams and also the steel roof trusses. The lower chords of these trusses are 56.5 ft. above the floor of the turbine room.

Beneath the floor of the turbine room are three sluiceways that carry sea water for condensing to and from the turbine units. Two of these sluice ways are equal in size and each of these carries the cold sea water to six turbines. The third sluiceway is larger and carries the heated water from the entire row of twelve turbines back to the harbor. Each of the sluiceways is of horseshoe shape, and the discharge sluice is 10 ft. wide and 9 ft. 3 in. high. In width each of the smaller sluices is 8 ft. 3 in., and in height 7 ft. 9 in. All three sluices have the same bottom level and the top level of each of the suction sluices is 21 ft. 9 in. below the floor of the turbine

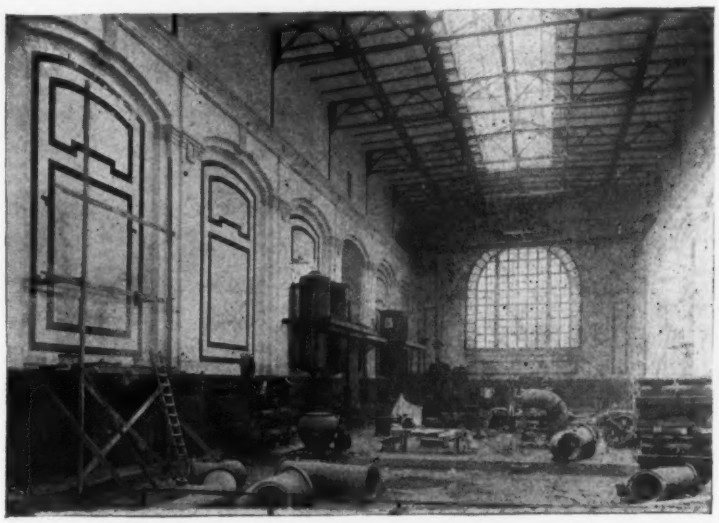


FIG. 3.—INTERIOR OF NEW PORTION, BOSTON EDISON PLANT.

room and 3 ft. 9 in. below the water level at mean low tide in the harbor. Directly in front of the turbine house and about 108 ft. therefrom are the gates for the suction sluices and beyond these but just inside of the face of the bulkhead is the large entrance chamber where the two suction sluices terminate. A channel has been dredged from the mouth of this chamber out into deep water, and over its mouth a screen is located to keep floating objects out of the suction sluices. The discharge sluice goes clear to the face of the bulkhead and a deflecting wall gives the hot discharged water a direction away from the entrance chamber.

Near each turbine unit there are grouped a centrifugal pump with direct-connected engine to handle the condensing water, a wet vacuum pump direct-connected to its driving engine, a steam-driven boiler feed pump, a steam-driven oil feed pump for the step bearing of the turbine, an accumulator to store oil under pressure for the turbine bearing, a separator between the condenser and the dry air pump to prevent the passage of water to the latter and a feed water heater and a hot well for the storage of water arranged side by side on the wall. Feed water for the boilers is drawn from the city mains and this water after condensation is used over and over, so that the loss is very small. Much of the piping between the various pieces of apparatus just named is carried in conduits beneath the concrete floor of the turbine room. Other conduits beneath this floor receive the electric cables from the turbines, and these cables then pass to the basement of the switch house where the floor is 2 ft. 3 in. below that of the turbine. After emerging from the cable terminals in this basement the high-voltage cables run to motor-operated oil switches on the second floor of the

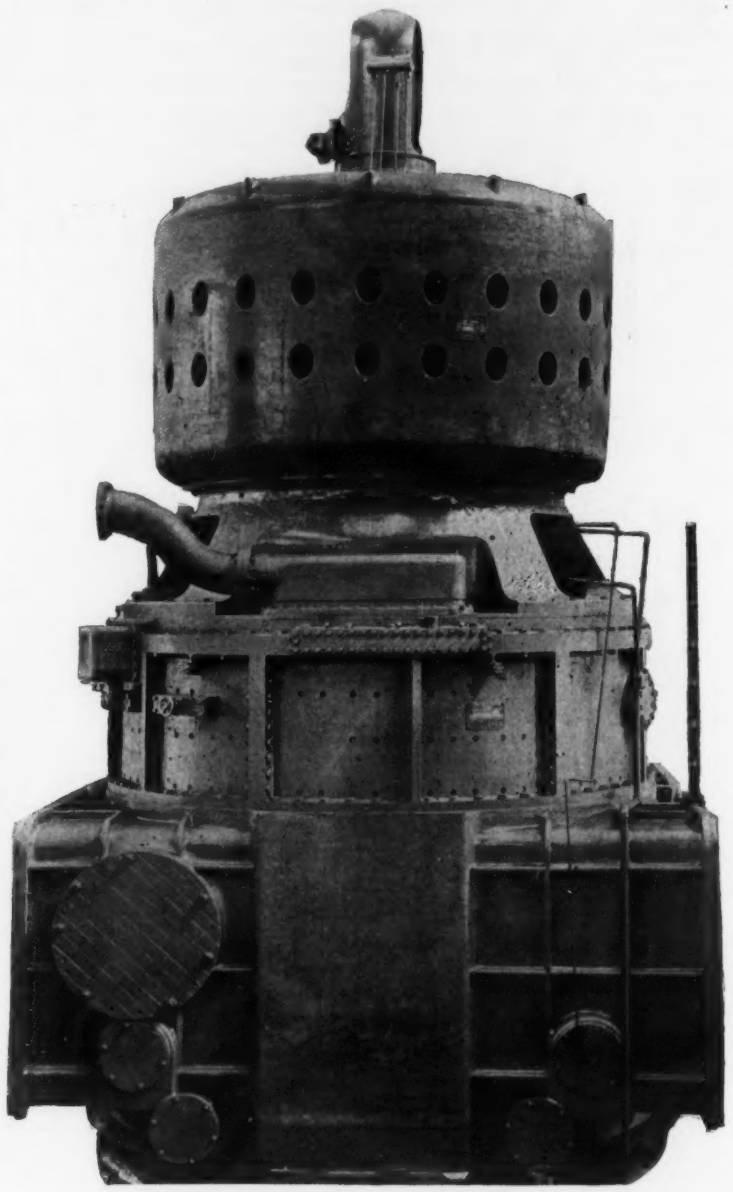


FIG. 4.—FOUR-STAGE CURTIS 5000 KW TURBINE FOR BOSTON PLANT.

switch house, and these switches complete the connections with the four sets of bus-bars on the first floor. On this first floor there are also located the knife switches for opening lines that are not in use, the lightning arresters and the instrument transformers.

The operating room of the switch house is on the third floor and here are located control switches for the oil switches below that make connections between the bus-bars and the generators and the outgoing cables. On this floor there are also control switches for the transformers that raise the voltage of the current from the generators in the old station, and also exciter panels for all of the generators in both the old station and the turbine station. The Corey signal system for both stations is also on this floor. As already pointed out, the switch house lies between the generator room of the old station and the turbine room of the new. From the operating room of the switch house one may pass through a door on one side to the switchboard gallery of the old station, or through a door on the opposite side to an observation gallery that projects out into the new turbine room.

In that part of the old station on the opposite side from the switch house is the coal pocket, and directly in line with this pocket is the coal wharf of the company which extends out into the dock a distance of about 368 ft. On this wharf there are now two coal derricks and a third is to be added. One of the present derricks has a one-ton bucket and works on only one side; the other derrick has a 1½-ton bucket and works on either side. The third derrick will have an equal capacity with the second. Running almost the entire length of the coal wharf and into the coal pocket there is a Robins 36-in. belt conveyor with a maximum capacity of 700 tons of coal per hour. A Hunt conveyor in the coal pocket distributes the coal. At the front end of this pocket there is a crusher that reduces the run-of-mine coal to 4-in. cubes.

Before entering the crusher the coal passes over a sort of screen or grating that allows the finer parts to fall through. Adjoining the coal pocket side of the old station and approximately 288 ft. by 516 ft. in area there is an open air yard for the storage of coal. The storage of coal on this large scale is thought to be desirable to avoid any possible shortage and because the cost per ton of the transportation of coal by water to Boston is the best part of a dollar higher in winter than in summer. In order to distribute coal over this large open storage area, belts numbered 2 and 4 are located across the end of No. 1 belt, that runs along the wharf as already mentioned, and No. 3 belt that is located in the open yard parallel with No. 1. The belts of conveyors Nos. 2, 3 and 4, like No. 1, are each 36 in. wide. After the coal has been dumped in a narrow pile extending the length of the yard under belt No. 3, it must be moved and piled in other parts of the yard, and for this purpose a Brown traveling bridge is employed.

This bridge is a steel truss 248 ft. long mounted on steel towers that move on tracks which extend the entire length of the yard. One of these tracks has a single and the other has two rails, and the distance of these tracks between centers is about 156 ft. One of its supporting towers is under that end of the bridge which is the more distant from the coal pocket in the old station, and the other end of the bridge overhangs the No. 3 belt conveyor that runs nearly the length of the yard. Beneath the bridge there is a motor-driven carriage that carries an attendant and also a 2-ton coal bucket. This carriage travels the entire length of the bridge, and this motion, together with that of the entire bridge up and down the yard, enables coal to be picked up at any point therein and dropped either on the belt conveyor or at any other point in the yard.

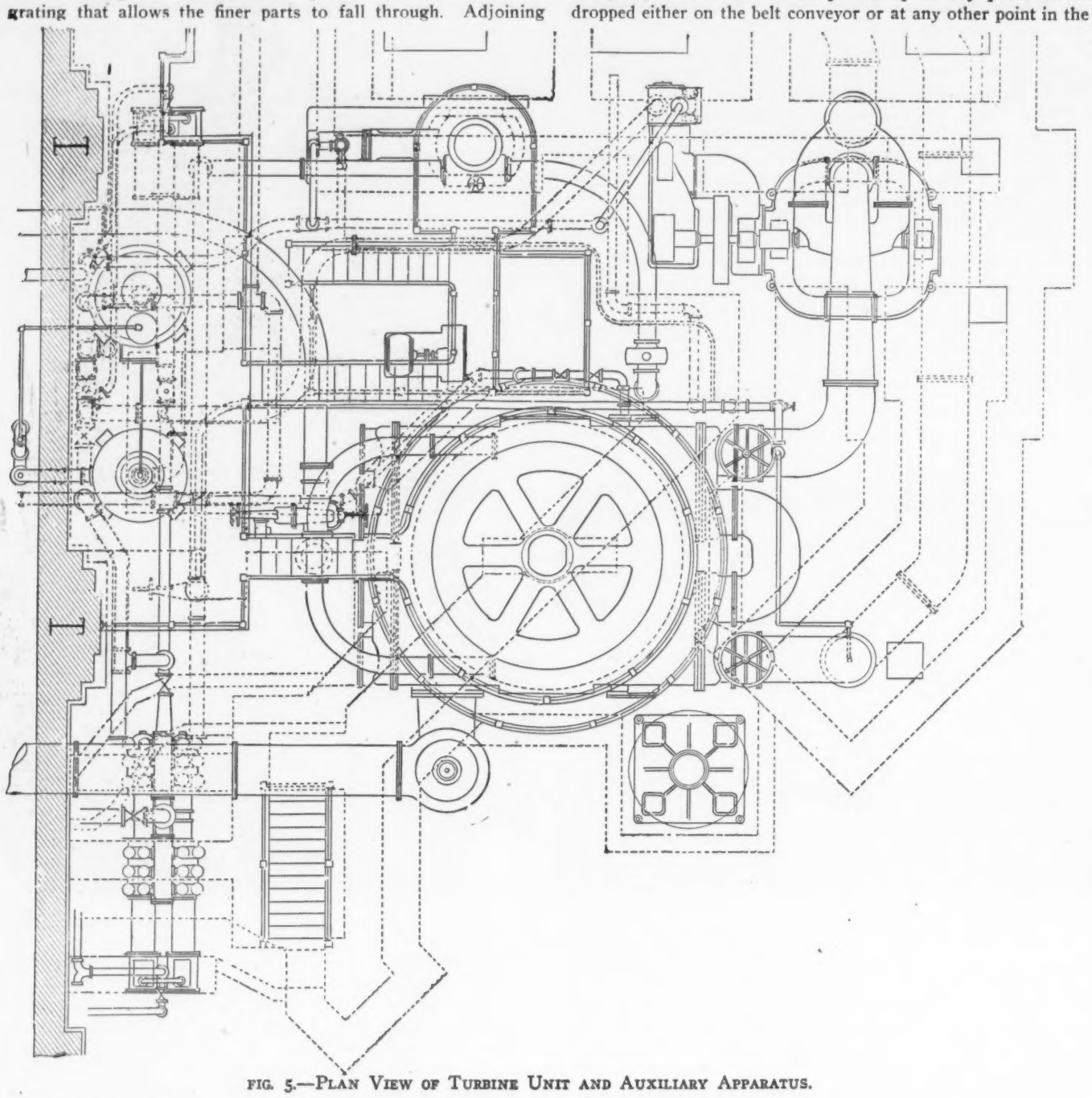


FIG. 5.—PLAN VIEW OF TURBINE UNIT AND AUXILIARY APPARATUS.

From the coal pocket at the side of the old station a belt conveyor is intended to run over the roofs of the turbine and boiler houses for each row of eight boilers that supplies a single turbine unit. Each of the conveyors for this purpose has a belt 20 in. wide, and there will be twelve such conveyors when the proposed turbine station is completed. In front of and above each row of eight boilers the coal bunker into which the conveyor belt empties has a capacity of 44 tons of coal, good for 1½ days' operation at full capacity. From the bunkers this coal passes to Roney stokers with 110 sq. ft. of grate surface per 500-hp boiler. These stokers are driven by induction motors.

All the boilers are of the Babcock & Wilcox water tube type,

and each has 152 tubes arranged 14 tubes wide and 18 high. Each tube is 4 in. in outside diameter and 18 ft. long. The tubes of each boiler connect with two 42-in. diameter steam and water drums and the superheater coils occupy a space between the tubes and the under sides of these drums. The tubes and the lower halves of the steam and water drums in each boiler give 5,120 sq. ft. of heating surface, or a little more than 10 sq. ft. of surface per horse-power at a nominal rating of 500 hp per boiler. The hot well for each row of eight boilers is normally nearly empty, and is connected by an automatic valve with the city mains.

The feed water heater for each row of boilers contains 1,600 sq. ft. of coil, is of the National type, and is mounted beside the hot well on the wall of the turbine room near each turbine. Each heater is expected to add 118° to the temperature of the boiler water when it has all of the steam that it can utilize. It is not quite certain at what temperature the water of condensation from the turbines will reach the feed water heaters, but the expectation is that the water will be returned to the boilers with a temperature somewhere between 170° and 200° F. The normal pressure of boiler steam is to be 175 pounds with 150° of superheat. As already pointed out, the circulating pump for condensing water, the boiler feed pumps, the dry vacuum pumps and the oil pumps are all steam-driven, feed water from the 17 by 12 by 15-in. duplex back plunger pump that sits near the turbine. In the dry air pump the 10 by 18-in. steam cylinder is horizontal and the 24 by 18-in. air cylinder is vertical, as this arrangement permits the use of a small fly-wheel. Steam entering this pump is controlled by a throttling governor. To keep water out of this pump, a 10-in. separator is connected between it and the condenser. For handling the condensing water the centrifugal pump at each turbine is of the Worthington volute type, 24-in. size, and is driven by a direct-connected Fleming Harrisburg side crank engine with 15 by 15-in. cylinder, at 200 r.p.m. This engine has a throttling governor.

The circuit of the condensing water through its pump and the condenser forms a syphon, so that the pump is only obliged to give the water a velocity head and to overcome the friction. Though the floor of the turbine room is 16 ft. above mean low tide water, it is estimated that the maximum lift of the pump that handles the condensing water will be less than 10 ft. Each turbine may draw its condensing water from either of the two suction sluices above considered, and this makes it possible to discontinue the use of either of these sluices for the purpose of cleaning or any other reason. The Worthington volute wet vacuum pump is driven by a direct-connected 10-hp motor of the induction type.

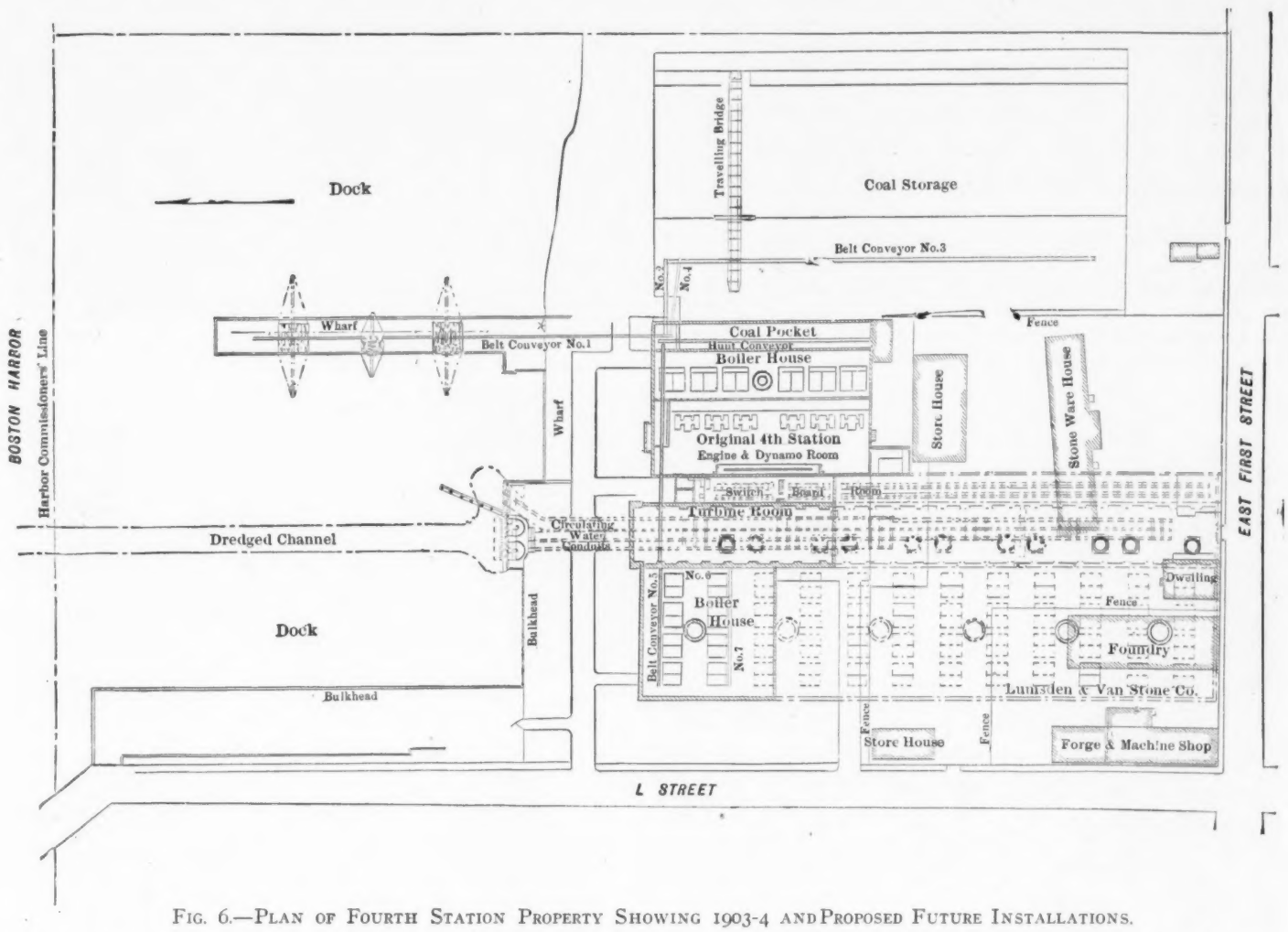


FIG. 6.—PLAN OF FOURTH STATION PROPERTY SHOWING 1903-4 AND PROPOSED FUTURE INSTALLATIONS.

and steam instead of electric drive is used for these pumps because there is not as much exhaust steam available as could be used in the feed water heaters.

No economizers are to be used in this plant, but the gases of combustion from each end group of eight boilers go directly to their chimney through a short iron flue of 8 by 20 ft. cross-section. Each chimney thus receives the gases from 16 boilers through two flues of this size on opposite sides. The number of chimneys for the completed station is thus six, there being one chimney for every two turbine units. Gases from boilers of 8,000 hp nominal rating thus pass to each chimney, which is round in plan with a height of 250 ft. above the foundation, and interior diameters of 18 ft. at the bottom and 16 ft. at the top. These chimneys are constructed by the Alphons Custodis Chimney Construction Company.

The eight boilers that supply steam to each turbine receive their

The steam-driven oil pump that supplies oil for the step bearing of each turbine has cylinders 10 by 2½ by 10 in., and can maintain an oil pressure of 11,000 pounds per sq. in. The oil cylinder of this pump connects with an accumulator that has a 12-in. ram with a 10-ft., 3-in. stroke, and stores 60 gallons of oil, enough to run the step bearing for 10 minutes after the pump stops. At the turbine step the oil pressure is 800 pounds per sq. in.

Each of the 5,000-kw turbo-electric units is of the vertical type, General Electric make, has a weight of 260 tons and stands 29.5 ft. high above the floor. A system of iron stairway and platforms gives ready access to all sides of the turbine. The electric generator of the turbine weighs 82 tons, and the armature alone 42 tons. It has 14 poles and operates at 514 r.p.m., so that the current developed has 60 cycles per second. The Y-connected armature yields 6,900 volts, three-phase. The outside diameter of the generator is 12 ft.

3 in. For maximum exciting current in the magnet coils the required power is 28 kw, or 0.56 of one per cent. of the rated armature output. The exciting current for the turbine generators is supplied at 125 volts, and for the present will be drawn from dynamos in the old station by way of the operating room in the switch house. In each turbine room the great Niles crane that sweeps over all of the equipment is entirely motor-driven and has a lifting capacity of fifty tons.

From each turbine generator the 6,900-volt, three-phase current passes to a pair of 800-amp., 15,000-volt oil switches on the second floor of the switch house, and through these switches to double sets

FIG. 7.—MAP OF BOSTON EDISON LIGHTING AREA, 1904.

of three-conductor bus-bars in brick and stone compartments on the floor below. On these bus-bars each connection between a cable and its bar is contained in a separate compartment. Some of the transmission lines to the distant towns supplied by the Edison system are connected to these 6,900-volt bus-bars through 15,000-volt, 300-amp. oil switches. For some of the other transmission lines a voltage of 4,600 is desired, and double sets of three-phase bus-bars of this voltage are, accordingly, mounted in compartments like those for the 6,900-volt bars. In order to obtain the 4,600-volt current and also the 6,900-volt current while the turbine plant has been under construction, transformers have been resorted to. These transformers draw their energy from the main generators in the old L Street station, which operate at 2,300 volts, 60 cycles, three-phase. Space for the transformers in question has been provided by a building at the rear of the old station.

This building is a one-story structure of brick, steel and concrete, with the transformers in the main room and air chambers underneath. In this building there are at present six air-blast transformers of the General Electric make. Each of three of these transformers is rated at 900 kw and has a ratio of three to one between primary and secondary windings, so that with 2,300-volt current from the old generators at the L Street station, a current of 6,900 volts can be delivered to the bus-bars in the switch house. The other group of three transformers have a capacity of 500 kw each, and change the current from 2,300 to 7,960-2,650 volts, from which the pressure of 4,600 volts for the bus-bars can be obtained by suitable connections. Two blowers each driven by a 5-hp, 6-amp., 550-volt induction motor are used to maintain the air pressure in the chamber under the transformers.

The 900-kw transformers are connected to the high-voltage bus-bars through 15,000-volt, 500-amp. oil switches, and the 500-kw transformers are so connected through 15,000-volt, 300-amp. oil switches. To connect the primary windings of the 900-kw transformers with the 2,300-volt bus-bars of the old generators, two 1,200-amp., 2,300-volt oil switches are employed. From the 4,600 and 6,900-volt bus-bars at the L Street station energy is transmitted to the various sub-stations of the Edison system.

Though the design of the new station at L Street contemplates its ultimate extension, so as to include a generating capacity of 60,000 kw, the present structure is of much smaller capacity. The turbine room now nearing completion covers one-third of the area for which the entire turbine house is designed, and provides room for four of the 5,000-kw turbine units. Present plans, however, call for the installation of only two of these turbine generators. Following the present equipment of the turbine room the boiler house has been constructed so as to allow the erection of two rows of boilers, sixteen in all, connected with a single chimney.

These equipments give the new turbine plant a generating capacity of 10,000 kw, and a little more than double the capacity of the L Street station. At this point it is interesting to note the rise in generating capacity of the Boston Edison system. The first station of this system was a rented building located between Bumstead Court and Head Place, and contained at the start a Babcock & Wilcox boiler rated at 200 hp, one 90-hp Armington & Sims engine and two Edison dynamos, type H, of about 400 16-cp lamp capacity each. On the basis of 4 watts per candle-power the kilowatt rating of each of these dynamos would have been 25.6 and 51.2 kw for the pair. This station was first started on February 20, 1886. The equipment at this station was soon increased by the addition of other boilers, similar engines and four type H and two type S Edison dynamos, so that it had a capacity of 2,400 16-cp lamps, or 153.6 kw on the 4 watts per candle-power basis in the H dynamos before the end of

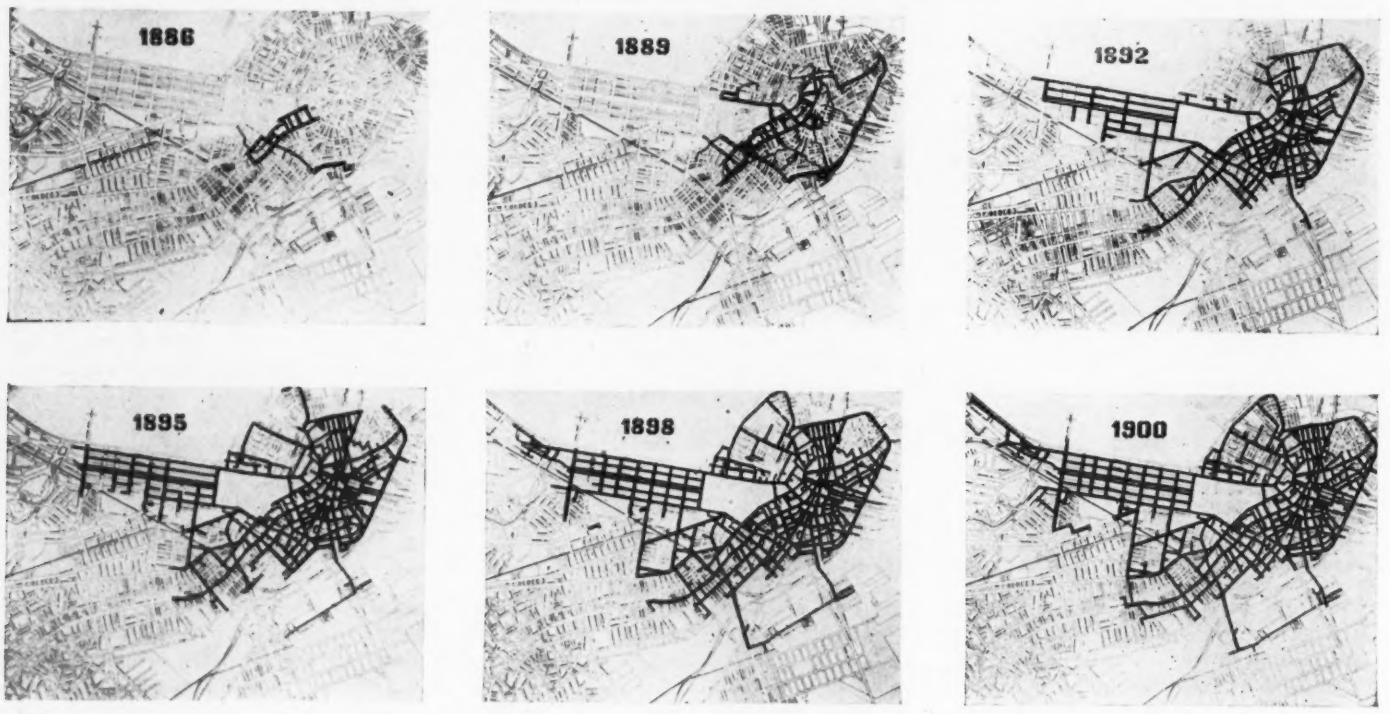


FIG. 8.—MAPS SHOWING GROWTH OF BOSTON EDISON LIGHTING AREA AND CIRCUITS.

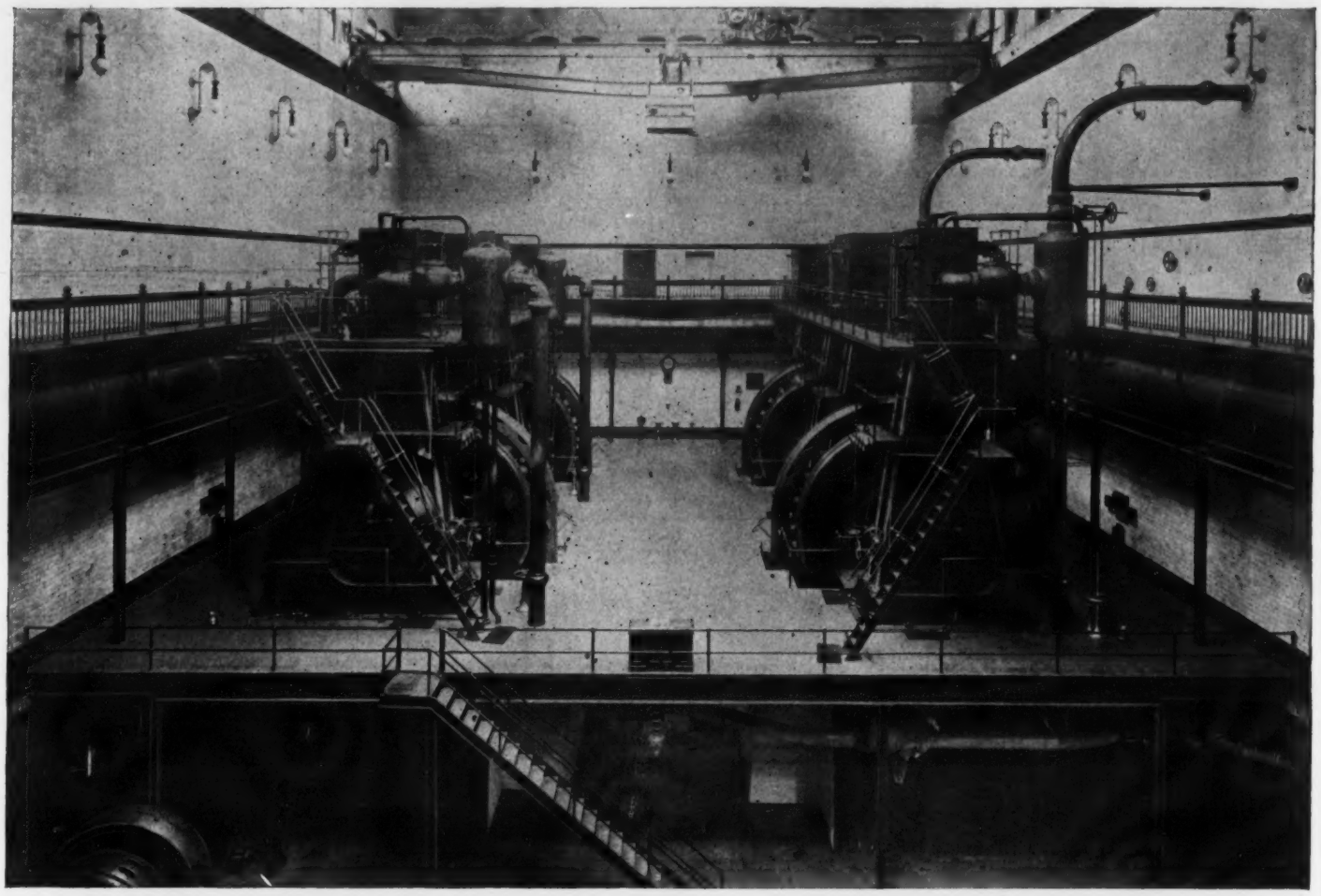


FIG. 9.—NEW ENGINE ROOM, THIRD STATION, BOSTON EDISON SYSTEM.

FIG. 10.—ENGINE ROOM, L STREET STATION, BOSTON EDISON SYSTEM.

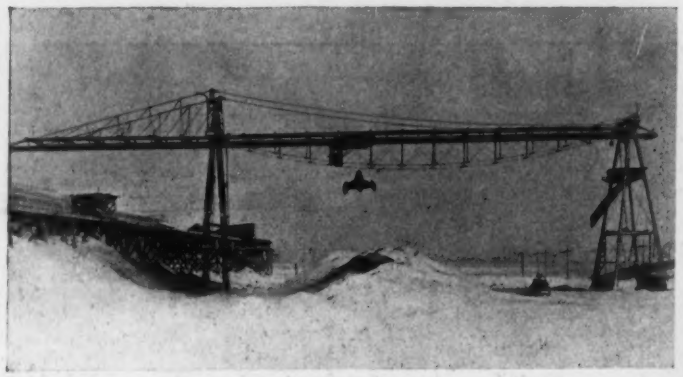


FIG. 11.—CONVEYOR BRIDGE.

FIG. 12.—GENERAL VIEW OF COAL CONVEYOR.

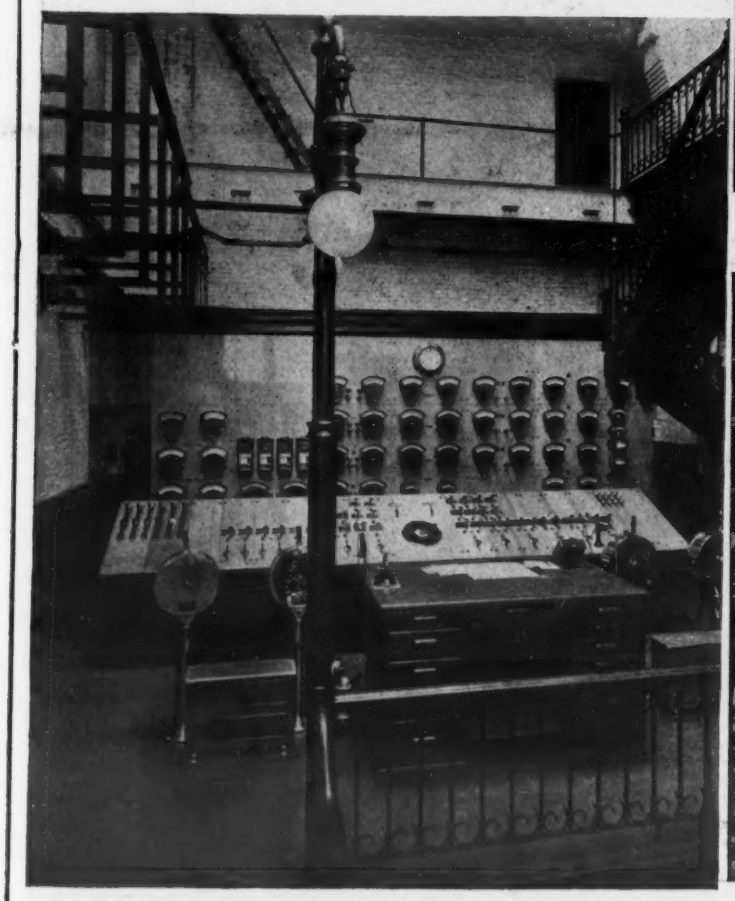


FIG. 13.—OPERATING BOARD, THIRD STATION.

FIG. 14.—COAL CONVEYOR.

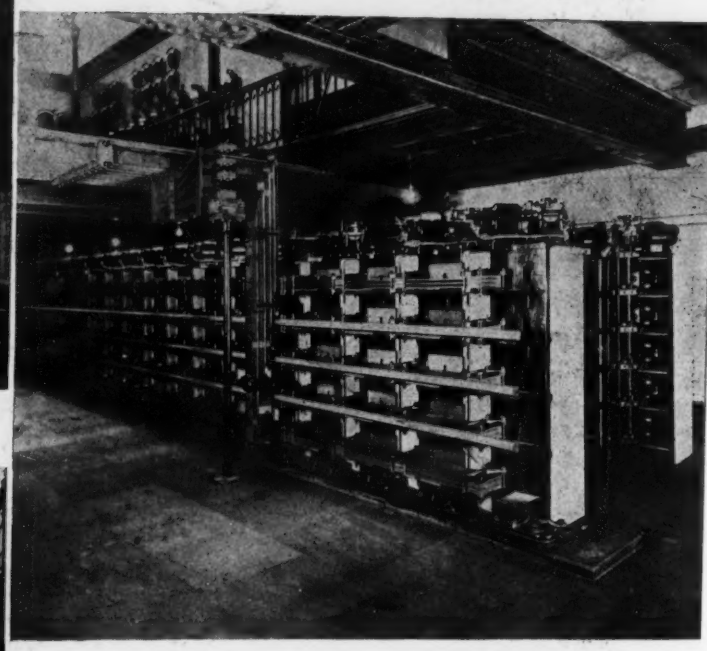


FIG. 15.—BUS-BARS, THIRD STATION.

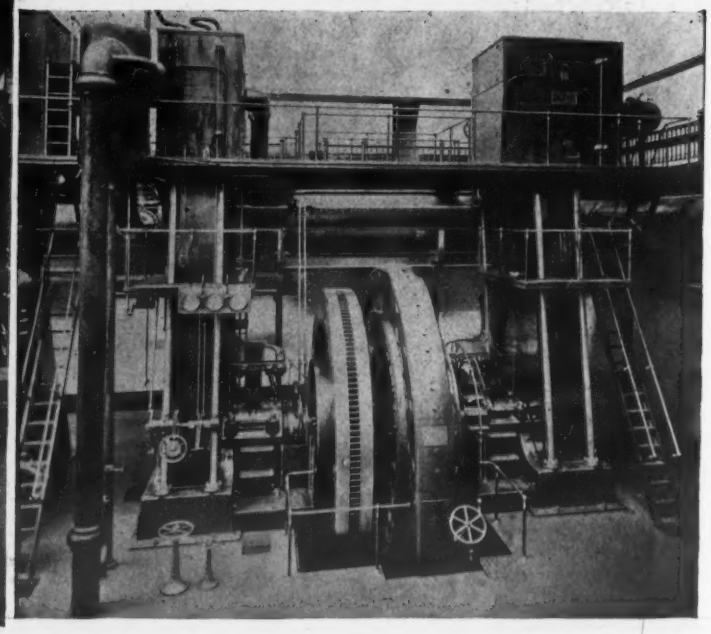


FIG. 16.—ONE OF THE LATEST GENERATORS AT THE THIRD STATION.

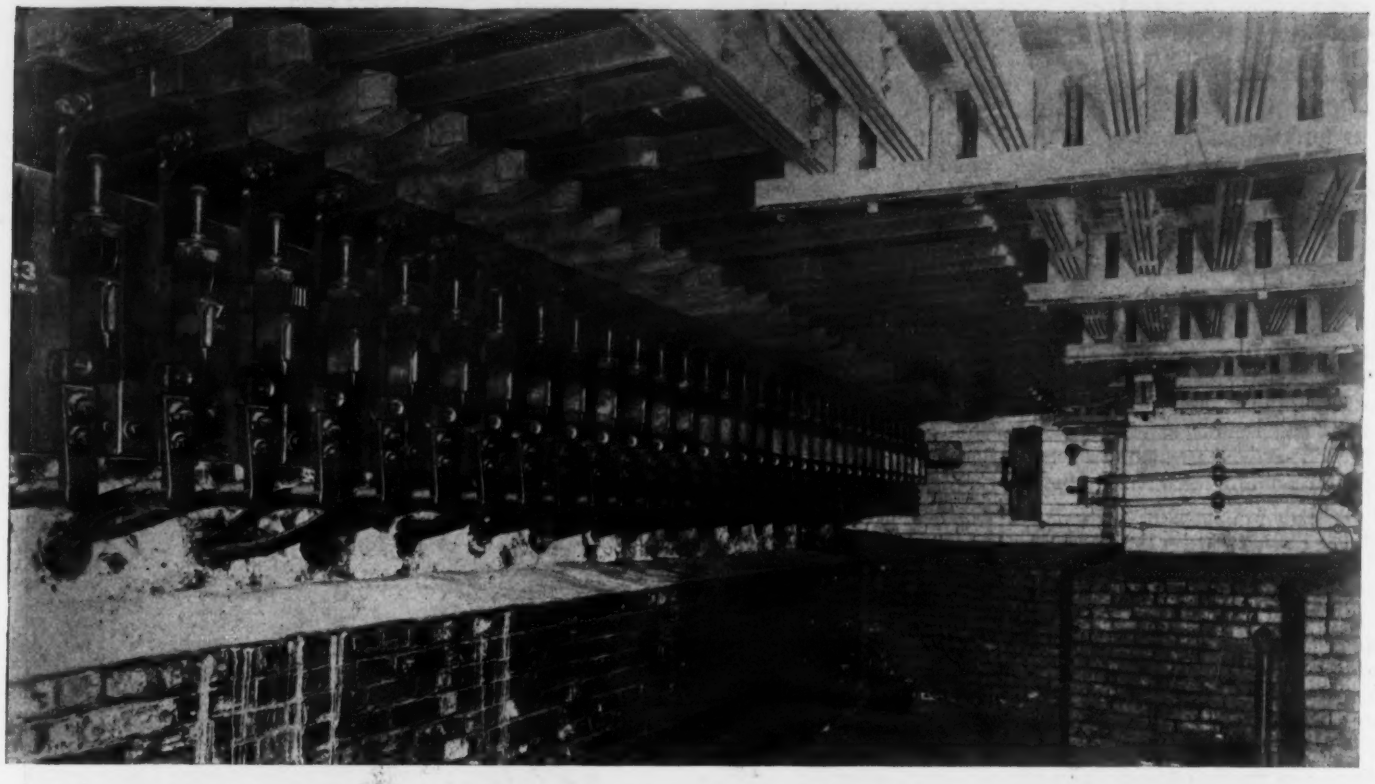


FIG. 17.—CABLES ENTERING THIRD STATION.

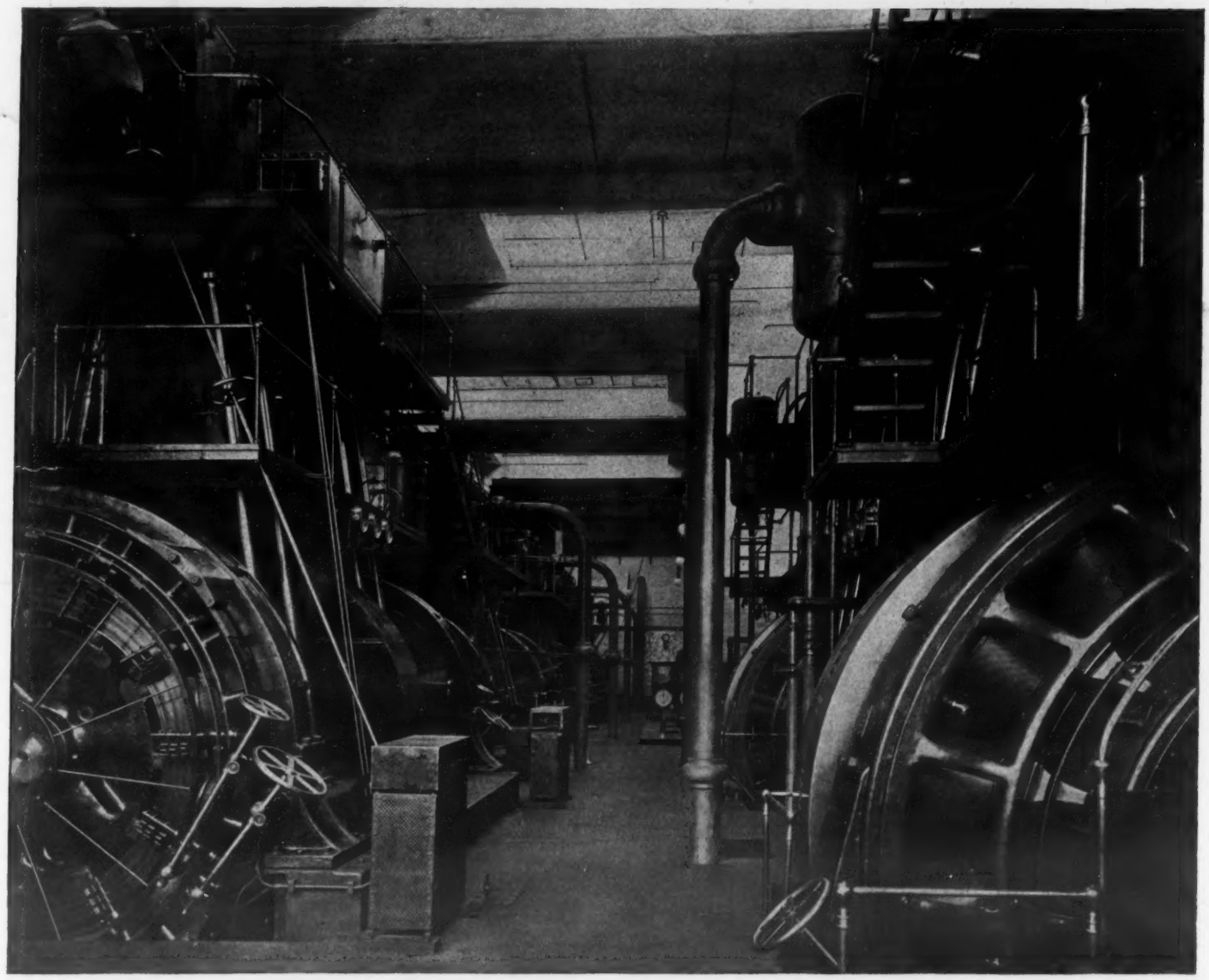


FIG. 18.—VIEW IN THE OLD ENGINE ROOM, BOSTON EDISON ATLANTIC AVENUE STATION.

the year in which it was started. Even this rapid increase was not sufficient to meet the growing demand for electric light, and a new two-story brick station, 50 by 70 ft. in ground area was erected adjoining the old one in the early months of 1887. This new station was designed for twenty Armington & Sims engines of 150 hp each, and forty Edison No. 20 bipolar dynamos. Two of these dynamos were belted to each engine, and were operated in series on the three-wire system, with approximately 250 volts on the outside wires. This station was started in June, 1887, with seven of the engines and fourteen of the dynamos just named. Rating these fourteen dynamos at 60 kw each gives the capacity of the new station as 840 kw at the start.

In order to reach the north end of the city a second station was built shortly after the first and consisted of a two-story brick building with a ground area 164 ft. deep between Hawkins and Bowker Streets, and a frontage of 38 ft. 3 in. on the former and 15 ft. 3 in. on the latter. This second station was started on December 21, 1887, with an equipment of two Heine boilers, one of 200 and the other of 400 hp, four Armington & Sims high-speed engines of 150 hp each, like those at the first station, and eight of the No. 20 Edison dynamos belted in pairs to the engines. At 60 kw each the rating of these eight dynamos would amount to 480 kw, and this added to the capacity at the first station gives a total of 1,320 kw for all the dynamos of the system on the date last named. This second station was designed for an ultimate equipment of 12 of the 150-hp engines and 24 of the 60-kw dynamos, which with the 40 dynamos that could be installed at the first station would give a total equipment of 64 of these 60-kw dynamos.

This limit to the generating capacity of both the second and third stations was reached before the middle of 1891, when 64 dynamos had all been installed, giving a capacity of 3,840 kw. A third generating station was then seen to be necessary and a site on the harbor front at the foot of Pearl Street, between Atlantic Avenue and the water was selected. This site had the advantages not possessed by the first and second stations, of sea water for condensing purposes, and of the direct delivery of coal from vessels. Ground was broken for the third or Atlantic Avenue station on October 10, 1891, on the site just mentioned where English tea ships were unloaded free of charge almost 118 years earlier; that is, on December 16, 1773. This third station began operation in the latter half of 1892, and in its equipment as in its location it differed much from the two earlier plants. The boilers were all of the Babcock & Wilcox water tube type, and each had a water heating surface of 3,680 sq. ft. and was rated at 368 hp. Instead of small horizontal, high-

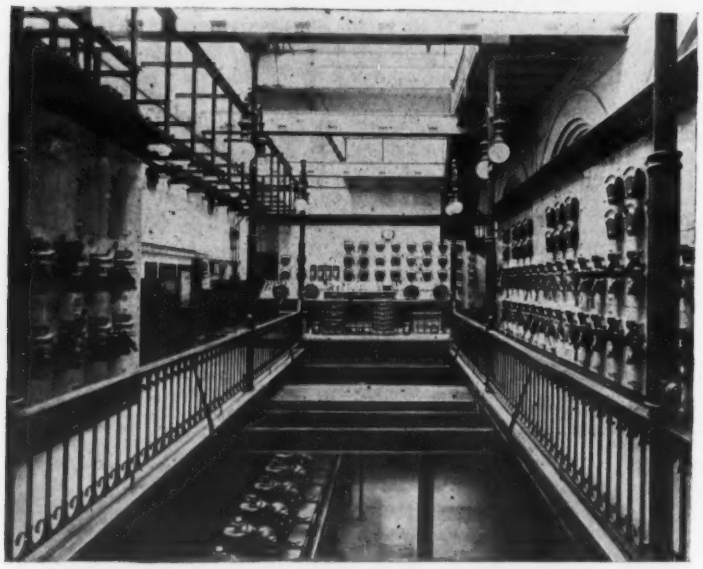


FIG. 19.—SWITCH HOUSE, THIRD STATION.

speed, simple, non-condensing, belted engines, like those at the first and second stations, the engines at the third station were of the large slow-speed, vertical, triple-expansion, condensing, direct-connected type.

Each of the first four engines installed at this third station had three vertical cylinders, carried a dynamo at each end of its shaft, and was rated at 660 hp with 120 r.p.m. and 160 pounds steam pressure. These engines were built by the J. Morgan Poole Company. Two multipolar dynamos were connected at opposite ends of the shaft at each of these four engines. Each dynamo was of Edison General Electric make, had 14 poles, was rated at 200 kw, and developed continuous current at 160 volts. This voltage of 160 for the dynamos at the Atlantic Avenue station was adopted in order to provide for the loss of pressure in the feeders between this station and the greater part of the service area of the Edison system at that time.

These eight dynamos of 200 kw each added a generating capacity

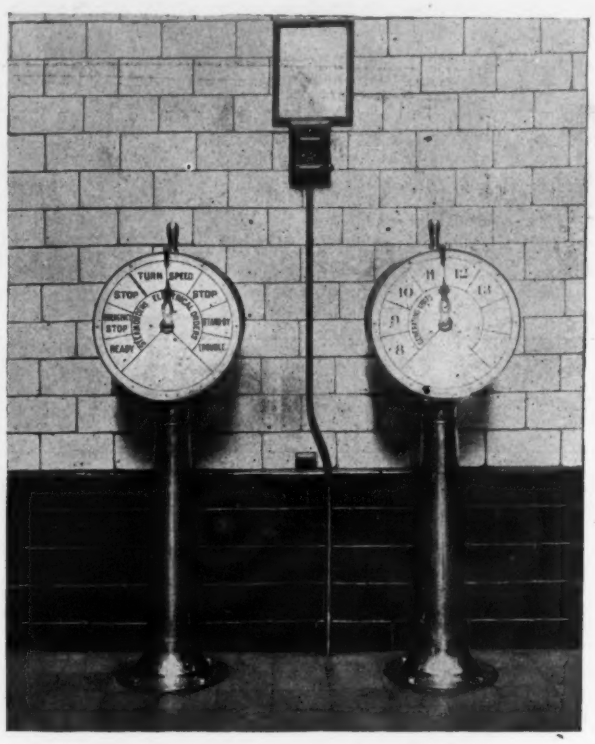


FIG. 20.—CONTROL DIALS, THIRD STATION.

of 1,600 kw to the Edison system, and brought the combined capacity of the three stations up to 5,440 kw, in 1892. This equipment, with the aid of storage batteries served to carry the increasing load of the Edison system until the year ending at the middle of 1896, during which a fifth vertical engine with two direct-connected generators was added at the third station. This engine was of the McIntosh & Seymour make, cross compound, condensing and rated at 1,200 hp with 100 r.p.m., and 160 pounds steam pressure. Each end of the shaft of this engine carries the armature of a 12-pole, 400-kw, 160-volt, continuous dynamo of General Electric make. These two dynamos brought the generating capacity of the three Edison stations up to 6,240 kw in 1896.

By 1899 another increase in generating capacity was necessary and this was made by the addition of two vertical engines, each direct-connected to a single multipolar dynamo. These engines are also of the McIntosh & Seymour make, cross compound, condensing, each rated at 1,200 hp with 160 pounds steam pressure and 100 r.p.m., and are located in the original engine room at the third station. Unlike the first five engines at that station, the two under consideration, numbered 6 and 7, carry only one generator, and this generator is mounted between the main bearings instead of at the end of the shaft. The two generators connected to Nos. 6 and 7 engines were made by the General Electric Company, and each is rated at 800 kw and 300 volts, continuous current.

These 300-volt generators, unlike the other ten in the old engine room of the third station, are each connected to only the outside wires of the three-wire system. Ballancing of the load on the two sides of the system is thus left to the other generators. The two dynamos driven by each of the first five engines at the third station are connected in series with their common terminal on the neutral wire of the system, and the other two poles of these two dynamos are connected respectively to the positive and negative wires, just as is the case with the pairs of bipolar dynamos belted to single engines at the first and second stations. By the two 800-kw dynamos the generating capacity of the three stations was increased to 7,720 kw, in 1899, deducting 120 kw for the capacity of two of the 60-kw

bipolar dynamos that had been taken for use as a motor-generator. Even this capacity was seen to be inadequate, especially as it was no longer desirable to operate the simple non-condensing engines at the first and second stations, and an extension of the third station building was begun in March, 1900, and completed the following year.

The old engine room at the third station had an area of 60 by 160 ft., including the switchboard room, which was 70 by 126 ft. in area. In this old engine room the 12 direct-connected generators have a combined capacity of 4,000 kw. For the new engine room at this station the ground area is about 150 by 85 ft., and the intended equipment is six direct-connected units of 1,600-kw capacity each. These figures for areas do not include the boiler room. Two of the generating units just named were installed in 1901, and two more have since been added. Each of these units consists of a McIntosh & Seymour vertical engine direct-connected to a General Electric generator mounted between the main bearings.

The engines are rated at 2,400 hp each with 160 pounds steam pressure and 100 r.p.m. All four engines are cross compound and they exhaust into a common condenser pipe of 50 in. diameter that extends entirely around the new engine room. The 1,600-kw generator driven by each of these engines operates at a maximum voltage of 300, and delivers continuous current to the outside wires of the three-wire system. One of these generators is designed to deliver both alternating and continuous current, has 30 poles and at 100 r.p.m. develops 184 volts alternating, six-phase, at 25 cycles per second. It was the intention when this generator was installed to use step-up transformers with it and obtain a high voltage for transmission to sub-stations, but the purchase of the L Street station of the Boston Electric Light Company shortly thereafter made it unnecessary to carry out this plan. With generators of 4,000 kw total capacity in the old engine room of the Atlantic Avenue station, and generators of 6,400 kw in the new engine room the total capacity there amounts to 10,400 kw. The old bipolar dynamos of 3,720-kw capacity, more or less, at the first and second stations can hardly be considered live generating apparatus at this date, but probably some of them could be put into service in case of a break-down at other stations.

Boilers at the third station have been increased in number as engines were added from time to time until now there are fifteen, all of the Babcock & Wilcox water tube type. Seven of these boilers contain 3,680 sq. ft. of water heating surface each, and the remaining eight each have 4,181 sq. ft. of such surface. In 1901 the sale of all the assets of the Boston Electric Light Company to the Edison Electric Illuminating Company brought the L Street station in South Boston to the latter company. This station was built in 1898 at the water front, as previously mentioned, on land formerly occupied by the Harrison Loring shipyard. In ground area the original L Street station, including the boiler room and coal pocket measures 174 by 244 ft. The boiler room is separated from the engine room by a brick wall and contains 12 Babcock & Wilcox boilers set in six batteries. Each of these boilers has a nominal rating of 500 hp and operates at 160 pounds as a standard pressure. In the engine room there are six vertical cross compound condensing engines of the McIntosh & Seymour make, each rated at 2,350 hp, with 160 pounds steam pressure and 120 r.p.m. Between the main bearings of each of these engines there is mounted a General Electric alternator with a rotating magnet frame of 60 poles.

Each alternator is rated at 1,500 kw and 2,250 volts, three-phase and 60-cycle. These six main generators supply current to 23 motor-generator sets located in the same room and also operate the transformers already mentioned that step up to 6,900 and 4,600 volts for the transmission lines, besides delivering energy to the distribution system in Boston at 2,250 volts. In these six alternators there is a combined capacity of 9,000 kw, and with the 10,400 kw of generator capacity at the Atlantic Avenue station the Edison system has at the present time 19,400 kw of main generators in position. This takes no account of the old bipolar dynamos at the first and second stations. The two 5,000-kw turbine alternators to be installed at the new L Street station will thus raise the capacity of live generating apparatus at L Street and Atlantic Avenue to 29,400 kw.

This rise of generating equipment from the two 25-kw dynamos of 1886 has been brought about by the increase of connected loads, the purchase of other lighting systems, and by transmission of energy to towns and cities distant in some cases more than 25 miles from either of the generating stations. At the middle of 1887, about 16 months after the little plant at Head Place began to operate, it was supplying current to 8,500 incandescent lamps on the premises of 200 customers, and to 80 electric motors with a total rated capacity of 250 hp. At the middle of 1901, before the purchase of the Boston Electric Light system had been completed, the circuits of the Edison Company were connected to 2,503 arc lamps, 247,935 incandescent lamps and to 2,621 motors with an aggregate rating of 10,651 hp. On the same date the Boston Electric Light system was operating 4,913 arc lamps, 112,636 incandescent lamps and 1,849 motors with an aggregate rating of 5,408 hp. The absorption of the Boston system and the growth of another year brought the load on Edison circuits at June 30, 1902, up to 442,034 incandescent lamps, 4,913 arc lamps and 18,621 hp in capacity of connected motors. Since the date last named the purchase by the Edison Company of a number of electric lighting systems in cities and towns within a radius of 25 miles from Boston, aided by the growth of business in that city, has given its lines a connected load of 681,162 incandescent lamps, 9,803 arc lamps and 24,225 hp in capacity of connected motors. All of the loads combined represent an equipment of 1,152,379 incandescent lamps of 16 cp each.

Veto of Niagara Power Bill.

Governor Odell, of New York, has vetoed the bill of Assemblyman Thompson enlarging the scope and powers of the Niagara, Lockport & Ontario Power Company. In his memorandum the Governor says that, while the bill is desired by the immediate locality concerned, he is convinced that throughout the State it is almost universally disapproved. He summarizes the history of the corporation since 1894, when the company was chartered by special act "to furnish pure and wholesome water for domestic purposes to the City of Lockport, as well as to generate and sell electricity in the Counties of Niagara, Orleans and Erie," and remarks that the time in which work was to have begun has about elapsed "without advantage having been taken of the valuable rights conferred by the original act." It is now proposed, he points out, to eliminate the water supply feature and extend to all the counties of the State the right to sell electric and hydraulic power, with very broad powers of condemnation and few restrictions or safeguards, and without in any way exacting compensation. There is nothing, he says, to prevent the sale of this charter to a competing company, and therefore competition is not assured.

"The plea that other corporations are enjoying similar privileges to those which this bill seeks to bestow is no justification," the Governor says, "for the continuance of policies which dissipate the rights of either the State or the municipalities. That governmental policy which does not respect the expressed will of our citizens in relation to both safeguarding their rights and exacting compensation for them is sure to meet with just criticism and disapproval.

"That these privileges are valuable is beyond question, and that the State has the right to demand a proper recompense for them, therefore, should never be lost sight of. That this proposed act does not take cognizance of these facts makes it, in my mind, undesirable legislation."

Governor Odell calls attention to the widespread solicitude, expressed in protests from all over the Union, as to peril to the beauty of Niagara Falls. On the question of threatened damage to the falls, he says, there is wide difference of opinion. "If the result, however, would be less harmful," says the Governor, "than those who seek for the preservation of the falls believe, it certainly would lead, or rather, be an excuse for other companies that would in the end produce the results which are feared. The Legislature should protect the falls, rather than increase the menace to which I have referred, by restricting those corporations which are already in possession, by compelling the removal of obstructions and unsightly structures which mar the beauty of Niagara."

Municipal Plant to Be Sold.

News from the west states that another town has become tired of municipal ownership. The electric lighting plant, located in and owned by the city of Leon, Iowa, has been offered for sale. Leon is the county seat of Decatur County and has a population of 2,000.

Some Aspects of New England Central Station Development.

UNDERGROUND CABLES AND CONDUITS IN NEW ENGLAND.

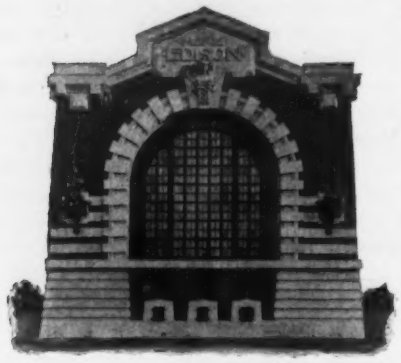


FIG. 1.—WINDOW BOSTON EDISON STATION.

EDISON tubes made up the first underground conduits and conductors in Massachusetts, and probably in New England. The five Edison companies in Massachusetts were early in the field, the Lawrence company having been incorporated in 1882, the Fall River and the Brockton companies in 1883, the New Bedford company in 1884, and the Boston company in 1885. All of these companies except that at Brockton appear to have installed underground tubes at the start, but in that city all of the electric light wires seem to have been overhead prior to the year ending on June 30, 1890.

On June 30, 1888, the Edison company at Boston had 64,530 ft., at Fall River 7,949 ft., and at Lawrence 7,000 ft. of underground tubes or conduits. For the Boston and Fall River companies the respective lengths of wire in conduits were exactly three times the lengths of these conduits, showing clearly the use of three-wire Edison tubes. At Lawrence, however, the length of wire in conduits was 41,347, showing that some conduit other than three-wire tubes was used. Though figures for the conduits of the New Bedford Edison Company are not available for the date last named, a part of the circuits there were no doubt underground, and the length of three-wire tubes on June 30, 1889, was 7,200 ft. Aside from the Edison systems just considered, the only underground electric lighting circuits in Massachusetts during 1888 were those at Pittsfield and Springfield, and the Pittsfield circuits were discontinued during the following year. The underground wires at Pittsfield measured 47,100 ft. on June 30, 1888, and belonged to the Pittsfield Illuminating Company, which operated Westinghouse dynamos. These dynamos were probably alternators of 1,000 volts, and this would indicate that the underground circuits were operated at the same pressure. As these circuits were discontinued during the following year, it is a fair presumption that their insulation gave way.

At Springfield the underground circuits were made up of single-conductor, rubber-insulated, lead-covered cables laid in wooden conduits or boxes and connected to 1,000-volt Westinghouse alternators. On June 30, 1888, the length of these conduits in Springfield was 4,700 ft., and the length of conductors therein was 29,000 ft. Unlike Pittsfield, the underground circuits at Springfield have been maintained and greatly extended, so that on June 30, 1903, the total length of conduits there was 101,385 ft., and they contained 518,992 ft. of wire. These wires varied in size from No. 8 to cables of 500,000 cm. cross section. Meantime the voltage on the underground circuits has been raised and varied so that they now operate at 2,500, 6,000 and 10,000 volts respectively. The present cables are of both the single-conductor and duplex types, and all are rubber-insulated and lead-covered. Cables operating at 10,000 volts carry direct current for arc lighting, and have one conductor each. Duplex cables carry 60-cycle, two-phase alternating currents, some at 2,500 volts for distribution from the sub-station, and others at 6,000 volts to complete the transmissions between the water power plants on the Chicopee River and the sub-station.

The rubber insulation on each conductor of the 10,000-volt cables is 7/32 in. thick, and is covered with a 5/64-in. sheath of lead. On each conductor of the 2,500-volt cable the rubber is 7/64 in. thick, and the lead outside of both conductors has a thickness of 3/32 in. The 6,000-volt cable has a rubber cover of ¼ in. on each conductor, and 3/32 in. of lead over the pair. All of the later underground construction has been with vitrified clay conduits in lengths of 18 in., and laid in beds of concrete 4 in. thick on top, bottom and sides. In these clay conduits each single duct has a 3-in. circular opening, and each multiple duct has a 4-in. square opening. Single ducts were so laid as to break end joints, were given ¼ in. of cement mortar between layers and about each joint of multiple ducts a strip of burlap 6 in. wide was placed after having been dipped in hot coal tar or neat Portland cement. The depth of trench in each case was such that the top of the layer of concrete over the ducts is 18 in. below the surface of the street.

In 1900 the population of Springfield was 62,059, so that it stood ninth among the cities of the State in this respect, but in the lengths of its underground cables and conduits it ranks next to Worcester and Boston. Until the year ending June 30, 1895, during which the Boston Electric Light Company and also the Brookline and Suburban Companies in that city laid considerable lengths of underground conduits, the Springfield system and the five Edison plants were the only ones in Massachusetts that maintained more than trifling lengths of electric light conductors underground. It thus appears that, with the single exception of the Springfield system, the Edison plants were more than a decade ahead of all others in the State in the construction of underground circuits.

Of course, a ready explanation of the priority of the Edison plants in underground work rests partly on the low voltage of 250 to 300, which has been maintained from first to last between the outside conductors of their three-wire distribution systems. This explanation brings out more clearly the enterprise of the managers of the Springfield system, in which alternating current of 1,000 volts was distributed through an extensive set of underground cables during seven or eight years before any successful attempt on a large scale

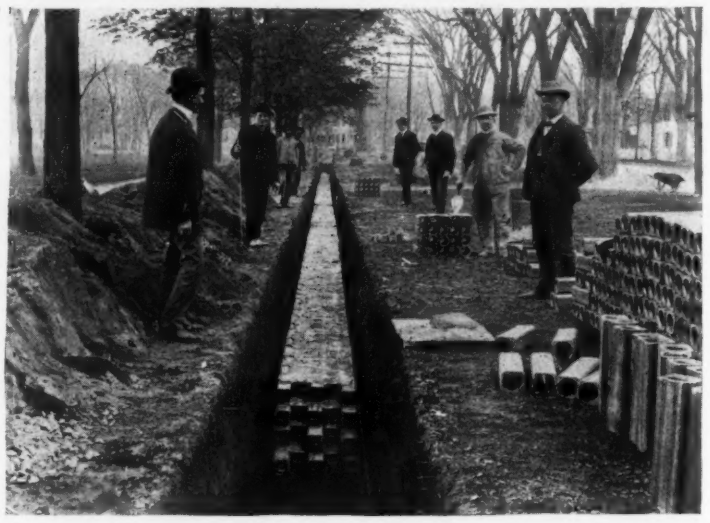


FIG. 2.—UNDERGROUND CONDUITS, SPRINGFIELD, MASS.

was made elsewhere in the State to operate underground circuits of more than 300 volts.

The figures for underground conductors in the electric lighting systems of Massachusetts on June 30, 1894, are interesting on this point. Aside from the five Edison systems above considered, the only lighting plants with underground wires in the State, and the lengths of these wires, were the Springfield with 67,272 ft., the Brookline with 1,000 ft., the Pittsfield with 1,000 ft., the Great Barrington with 450 ft., and the Winchendon with 198 ft.

Since June 30, 1895, when the Boston Electric Light Company had 387,806 ft., the Suburban company, of Boston, 9,656 ft., and the Brookline company 14,872 ft. of wire underground, the installation of underground conduits and cables has gone rapidly forward in some cities of Massachusetts. During the following year the Boston Electric Light Company increased its length of underground wires to 942,582 ft., and 25,000 ft. of wire was put into an equal length of underground conduit in the town of Lenox. At that time the Boston Electric Light Company was operating direct-current power circuits of about 500 volts, constant-current circuits from arc dynamos

that probably ranged from 2,500 to 10,000 volts, and circuits with alternating current at 1,000 or 2,000 volts. It is probable that parts of all these circuits were included in the underground work. In the Lenox underground system alternating current, probably single-phase at 1,000 volts, appears to have been used. Both the Suburban and the Brookline companies, like the Boston, were distributing 500-volt direct current for motors, constant current from arc dynamos, and alternating current for incandescent lighting, but it cannot be stated here which of these classes of service first went underground.

During the year ending June 30, 1897, the Worcester Electric Light Company brought the length of its underground conduits, which had been started during the previous year, up to 12,554 ft. On June 30, 1898, the length of wires that had been installed in the underground conduits of Worcester was 243,266 ft. At that time the Worcester company was operating 500-volt power circuits, constant-current circuits from arc dynamos, and circuits with alternating current of probably about 2,000 volts.

The next important addition to the group of lighting systems with underground conduits in Massachusetts was that at Lowell, where 8,206 ft. of wire were laid in 1,364 ft. of conduit during the year ending June 30, 1901. At that date the Lowell company was operating 500-volt power generators, constant-current arc dynamos, and 2,200-volt alternators. The Suburban company, of Boston, appears to have reached its maximum length of underground wires, 18,924 ft., during the year ending June 30, 1898, and from this date until

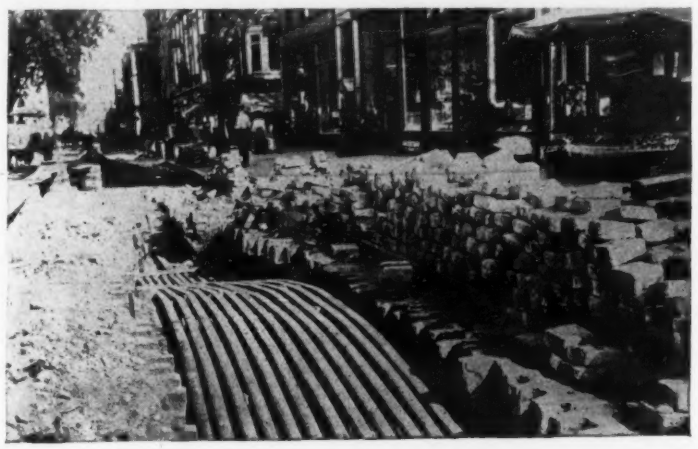


FIG. 3.—CROSSING A BRIDGE IN LOWELL WITH CABLES IN IRON PIPES.

the sale of its assets to the Boston Edison Company, on December 31, 1901, there was a decline in the length of these wires.

On February 28, 1902, the transfer of all the property of the Boston Electric Light Company to the Boston Edison Company was completed. On June 30, 1901, the former of these companies had installed 4,198,961 ft. of wire in 304,874 ft. of underground conduit. At the same date the wires of the Boston Edison Company, all underground, measured 2,029,583 ft. in 497,417 ft. of conduit. During the year ending June 30, 1899, the Malden Electric Company laid 1,200 ft. of wire in 1,000 ft. of underground conduit, but this wire seems to have been discontinued before June 30, 1902. During the year ending at the date just named the Suburban Company, of Revere, laid 6,400 ft. of wire in an equal length of underground conduits, and this remained the same a year later. This company operates with 2,300-volt alternators and 9,000-volt constant-current transformers. During the year ending June 30, 1891, the Pittsfield Electric Company laid 1,000 ft. of wire in 500 ft. of underground conduit, and the wire increased to 2,150 ft. on June 30, 1897, but had declined to 946 ft. on the corresponding day of 1904.

The Church Green plant, a system distributing direct current at about 110 or 220 volts in a small part of Boston, had laid 16,755 ft. of wire in underground conduits by June 30, 1897, but on the like day of 1902 this length had shrunk to 10,755 ft., and the system was sold to the Boston Edison Company on May 1, 1903. On June 30, 1903, the electric system at Winchendon, above noted, had increased its length of underground wires to 1,704 ft. in the same length of conduit. The Leominster plant had 150 ft. of wire underground at the date just named. In the electric system at Lynn 6,565 ft. of wire was put underground during the year ending June 30, 1902, and in the following year the length was increased to 10,618 ft. At Lenox the lengths of wires and conduits alike had increased to 51,023 ft. at the middle of 1903.

The larger electric lighting systems of the State had lengths of wires in underground conduits as follows on June 30, 1903:

Company.	Feet of conduit.	Feet of wire.
Boston Edison	876,315	6,592,181
Worcester	185,261	1,895,939
United (Springfield)	101,385	518,992
Fall River (Edison)	46,091	261,563
Brookline	26,686	84,776
New Bedford Edison	24,223	146,877
Lowell	21,050	115,525
Brockton Edison	18,503	68,364
Lawrence (Edison)	13,890	59,490

Each of the five Edison systems of the State has been consolidated with or has absorbed another competing system; but it seems that outside of Boston these other systems had no underground circuits. In New Bedford and Fall River at least, and probably in all of the other Edison plants, many of the original iron tubes buried twenty years ago are still doing regular service. In Lawrence the use of Edison underground tubes seems to have declined, for the greatest length of wires in conduits there was 72,797 ft., reached by the middle of 1891, with 7,200 ft. of conduit. Another decline in the extent of an Edison underground system is that at Brockton, where a length of 34,534 ft. of conduit and 123,903 ft. of wire therein was installed by the middle of 1894, but had shrunk as indicated by the table, in 1903.

In July, 1890, the Edison company, of New Bedford, was consolidated with the local gas company, which also did electric lighting, and at that time the Edison system included 24,000 ft. of wire in 8,000 ft. of underground conduit. At the time of the consolidation the gas company had no underground lines, but since that date the length of wires in conduits has been extended as indicated in the table. A part of the increase seems to have been made with Edison tubes, and a part with clay ducts.

On July 1, 1896, the Fall River Electric Light Company purchased the entire plant of the local Edison system, which then included 104,040 ft. of wire in 26,963 ft. of conduit. The purchasing company had no underground circuits at that time, but since then the length of wire in conduits has more than doubled. The increase of underground lines has been divided between Edison tubes and clay ducts, but future extensions will be made mainly with the latter.

As above noted, the length of underground wires in the system of the Boston Electric Light Company at the time of its absorption by the Boston Edison was more than 4,000,000 ft., and it follows that more than 60 per cent. of the wire shown in the table for the Boston Edison Company was derived from the Boston Electric system. As this latter system contained no Edison tubes, these tubes now carry less than four-tenths of the underground circuits of the Boston Edison Company.

The actual percentage of the wires of this company that are in Edison tubes must in fact be much below 40 per cent., for a large amount of clay conduit has been laid by it. The later practice in the Boston Edison system has been to lay all feeders with lead-covered cables in conduits, devoting the Edison tubes to mains and service taps. In May, 1901, before consolidation with the Boston Electric system the Edison system there included 301,329 ft. of tubes used as mains with conductors that varied in size from 200,000 to 350,000 cm., and 127,000 ft. of tubes used as feeders and containing 1,000,000-cm. conductors, all of these tubes being three-wire. There was also 17,000 ft. of tube used for the lines between the several stations and sub-stations. This gives a total of 428,329 ft. of Edison tube containing 1,284,987 ft. of conductors in use for mains and feeders. At the same time the Edison system contained 145,000 ft. of 1,000,000-cm., 35,000 ft. of 350,000-cm. cable, also 1,000 ft. of 12-conductor and 63,000 ft. of 3-conductor cable, all laid in conduits. The entire length of these cables was thus 449,000 ft. Most of this cable was insulated with rubber, but a part with paper, and 80,000 ft. of cement-lined iron duct and 371,000 ft. of clay duct were in use to carry the cables.

Between the L Street generating plant of the Boston Edison system and the sub-stations at Newton, Somerville, Woburn, Dedham, Milton and Natick, that are to distribute current in eighteen cities and towns within thirty miles of Boston, the transmission lines consist in part of underground cables. The completed length of these cables is 115,000 ft., and they are all laid in 3-in. vitrified clay conduit. Each cable carries three No. 4/0 copper wires insulated with paper and covered outside with a lead sheath that is 1/10 in. thick.

About each conductor the paper is 3/16 in. thick, the spaces between the three conductors of each cable are filled with jute, and outside of the three conductors, next to the lead sheath, there is another 3/16-in. layer of paper. These cables carry three-phase, 60-cycle current at 6,900 volts. Since June 30, 1903, the electric light and

power circuits in the central part of the business section of Lowell have all been put underground. This has largely increased the lengths of cable shown for the Lowell Company in the above table, but the length of conduit is about the same. In its present state the Lowell system includes about fifty miles of cables that vary in size from duplex No. 10 pressure wires to conductors of 500,000 cm. The cable is laid in tile conduits, as a rule, is mostly rubber-insulated, and is lead-covered. Much of this cable distributes 22,000-volt alternating current, and many of the transformers are in street manholes, from which secondary circuits of 110 volts are carried. At one point where the cables cross a bridge under its paving they are carried in iron pipes to save room. In Lowell the conduit system is continuous from the generating station on the bank of the Concord River to the business section.

At Providence, R. I., the Narragansett Electric Light Company began to put its wires underground in 1899, and since that time vitrified clay conduits have been laid in more than forty miles of streets. These conduits contain more than 1,700,000 ft. of ducts, of which about 700,000 ft. are in the multiple-duct form, and over 1,000,000 ft. are single-duct. Upwards of 850 manholes give access to the duct system, the standard size of each being 7 by 7 ft. square and 8 ft. deep. In front of the battery sub-station of the system there is a great manhole 21 ft. long, 8½ ft. wide and 9 ft. deep. Some of the manholes extend below the water level in Narragansett Bay, and it was necessary to make them water-proof with linings of tar paper put on with hot asphalt and then a layer of cement concrete. In junction manholes fuses connect the cables so that a defective section may be readily located.

All of the cables in these conduits are rubber-insulated and lead-covered, and all conductors larger than No. 6 B. & S. gauge are stranded. These cables carry voltages of 250 to 500 on a three-wire system, constant current for arc lighting at voltages up to 6,500 volts, 2,300-volt alternating current, and 11,000 volts on the transmission lines to the sub-stations at Warren and Warwick. For 500 volts and under the thickness of rubber insulation on cables is 5/32 in. The cables for 2,300 volts and for constant current up to 6,500 volts have rubber 7/32 in. thick on each conductor, and on the 11,000-volt cables the thickness of rubber is 9/32 in. There are four miles of this 11,000-volt cable in the conduits, and it connects with 800 ft. of armored cable that crosses the Seekonk River. In size of conductors the underground cables range from No. 14 to 1,000,000 cm. and their total length is 1,468,200 ft., or 278.06 miles. There is also 5,000 ft. of the armored submarine cable used with currents of the several voltages, used mainly in crossing the river to East Providence. Starting from the generating station on South Street at the water front the underground cables cover the entire central business section of the city and run out into the residence portion.

ELECTRIC TRANSMISSION FROM CITIES IN NEW ENGLAND.

Transmission of energy from water powers to distant cities has justly received much attention, but another important branch of transmission has sprung up without attracting much notice. This is the transmission from comparatively large cities to smaller and distant places. By such transmissions the populations and especially the areas supplied by single electric systems have been much extended within the period since 1890. In Massachusetts the electric supply systems of Boston, Cambridge, Haverhill, Lawrence, Lowell, Lynn, Malden, Marlboro, New Bedford, Springfield and North Adams, besides those of a number of smaller places now extend to other cities or towns. From the new generating station in Cambridge current of 2,300 volts, 60 cycles, three-phase is transmitted to Belmont, an adjoining town. In the towns of North Andover and Methuen, which bound the city of Lawrence on two sides, both public and commercial lighting is supplied directly from the water power station of the electric company in that city. The arc lamps used to light the streets in these towns are on series circuits, and commercial incandescent lamps are supplied through transformers on circuits of about 2,200 volts.

From the steam power station on the river bank in Lowell electric current is transmitted to the towns of Billerica, Tewksbury and Andover, all three within a ten-mile radius. The series incandescent street lamps in Billerica are controlled by a regulating transformer at the Billerica end of a 2,200-volt line from the bus-bars at the station. Commercial service in this town is also furnished through transformers on the 2,200-volt line. In Tewksbury incandescent street lamps are operated on a series circuit. For the transmission to Andover the 2,200-volt current at the Lowell station is raised by a transformer to 6,600 volts, and this pressure is reduced to 2,200 volts at the Andover end for distribution there. A part of this 2,200-volt current goes to a constant-current transformer in Andover for the operation of series arc and incandescent street lamps. In the town of Groveland, across the river from Haverhill, series incandescent street lamps are operated from the steam-driven electric station on the bank of the Merrimac in that city.

Four cities, Malden, Everett, Medford and Melrose, are all supplied with street and commercial lighting direct from a generating plant using steam power, in the former. These cities form a rather compact area of about six miles north and south, and a like distance east and west. Circuits of series arc and incandescent street lamps in all four cities are connected to constant-current transformers at the generating station in Malden. Commercial lighting and power is distributed in these cities from 2,200-volt circuits that also run back to the generating plant. Southboro, a town that adjoins Marlboro,

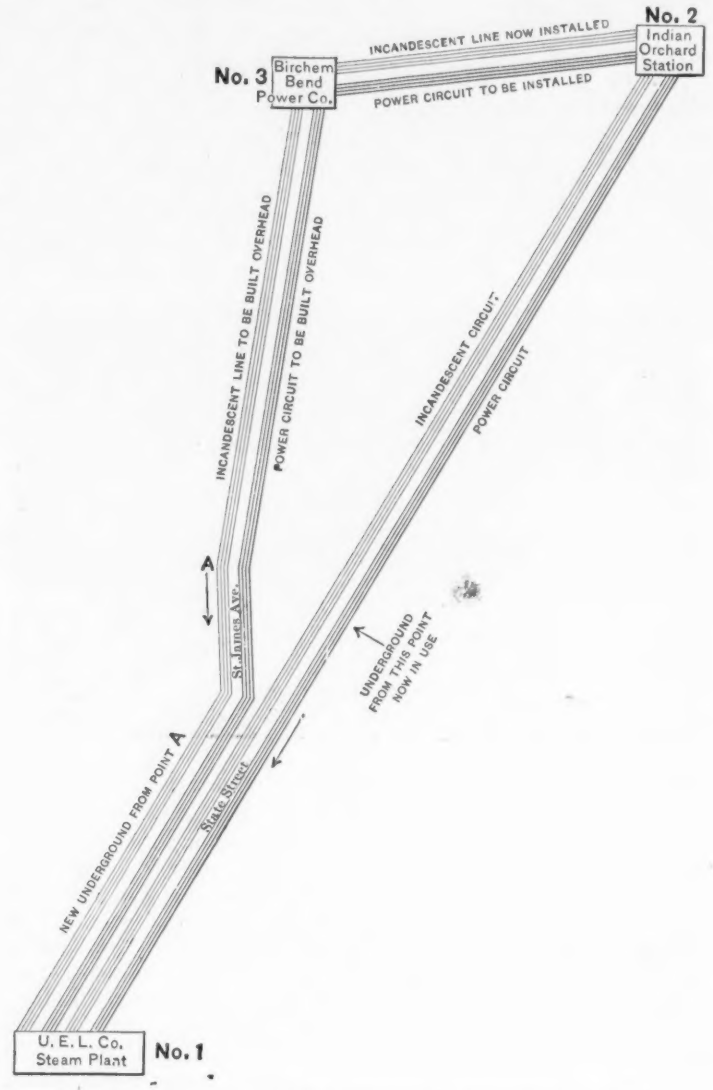


FIG. 4.—PLANT CONNECTING CIRCUITS, SPRINGFIELD, MASS.

is supplied with series incandescent street lamps, and with commercial lamps from circuits that start from the steam power electric station in that city. The steam power station on the water front in New Bedford supplies public and private service in Fairhaven by circuits that cross the river which separates the city and town. No step-up transformers are used, but all service in Fairhaven is taken either from constant, direct-current circuits or from 1,000-volt, single-phase lines that run back to the switchboard at the generating plant.

From the sub-station of the Springfield system, on the bank of the Connecticut River, distribution is carried out in that city and also in the adjoining towns of West Springfield and Longmeadow. For street and commercial lighting over this area constant-current arc circuits and two-phase circuits of 2,500 volts are utilized. The electric station in Pittsfield operates a constant-current circuit for incandescent street lamps in the town of Dalton. From the generating station in North Adams current is transmitted for public and private lighting in Adams, Williamstown and Clarksburg parts of which are eight to ten miles distant. For these transmissions the 2,200-volt, two-phase current at the main station is raised to 6,600 volts by trans-

formers there, and the 6,600-volt current is lowered in pressure at sub-stations in Adams and Williamstown. From these two sub-stations the local distribution takes place. In the town of Blackstone, Mass., the sub-station receives electrical energy transmitted across the State line from a generating plant at Woonsocket, R. I.

Much the largest and longest transmission between a city gen-

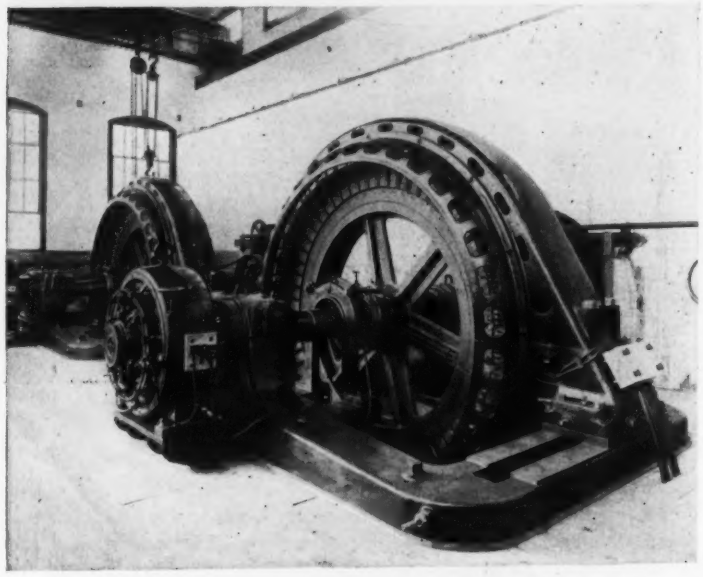


FIG. 5.—400-KW UNIT, SPRINGFIELD, MASS., BIRCHEM BEND PLANT.

erating station and other cities or towns in Massachusetts is that which is just being put into operation by the Edison Electric Illuminating Company, of Boston. This transmission starts from the L Street station of the Edison Company on the water front in South Boston and extends to eighteen cities and towns, some of which are fully 25 miles distant.

This transmission has been made possible through the purchase by the Edison Company of the electric generating stations and systems in Woburn, Somerville, Watertown, Needham, Dedham, Milton, Dover, Canton, Natick and Framingham. The operation of these

FIG. 6.—BIRCHEM BEND CANAL AND TAIL-RACE, SPRINGFIELD, MASS., PLANT.

systems carries with it the supply of electrical energy in Woburn, Stoneham, Winchester, Somerville, Arlington, Dedham, Canton, Needham, Milton, Westwood, Wellesley, Natick, Framingham, Wayland, Ashland and Holliston. For the regulation and distribution of electric current in all of these places from the L Street generating plant, sub-stations are being equipped at Woburn, Somerville, Newton, Dedham, Milton and Natick. Between the L Street station and each sub-station a transmission circuit for 6,900-volt, 60-cycle, three-phase current has been erected. Parts of these circuits in Boston and some of the other cities through which they pass are composed of three-conductor, paper-insulated, lead-covered cables laid in tile conduits, but the greater parts of their lengths are made up of bare copper and aluminum conductors supported by wooden poles. The 6,900-volt current for transmission from the L Street station is obtained there at present by means of transformers that draw their energy from the 2,300-volt, 60-cycle, three-phase generators in the older part of that station. When the addition to this L Street plant now under way is completed, the 6,900-volt current for the transmission circuits will be developed in the armature windings of

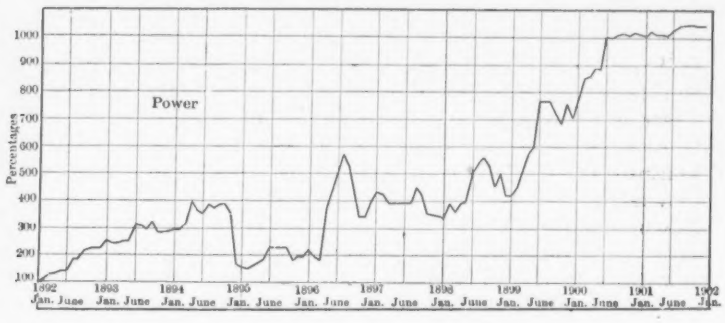


FIG. 7.—CURVE SHOWING INCREASE OF RECEIPTS, HARTFORD, CONN.

the 5,000-kw turbine generators that are being installed there. The circuits that now connect the L Street station with the most distant sub-stations of the system are thought to insure moderate transmission losses and good regulation, but when the loads at these distant sub-stations have increased, the transmission voltage at the generating plant may be raised to 13,500 by transformers.

At the various sub-stations connected to these 6,900-volt transmission circuits the line current goes either to static transformers or to motor-generators. The motors of these generating sets are three-phase, 60-cycle machines and receive the 6,900-volt current in their stationary armature windings. The generators of these sets deliver direct current. In the static transformers the three-phase current is reduced to 2,300 volts for general distribution, and for use in constant-current transformers and regulators. Such constant-current transformers and regulators supply all series circuits for both arc and incandescent lamps, and no constant-current dynamos are operated.

From the steam turbine generating station in Hartford, which also serves as a sub-station for the transmission lines that come in

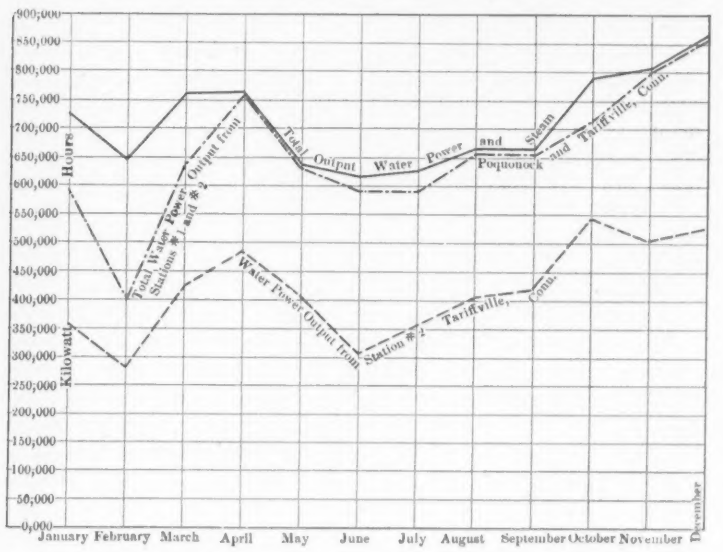


FIG. 8.—ENERGY OUTPUT CURVE, HARTFORD, CONN.

from the water power plants on the Farmington River, 2,400-volt, 60-cycle, two-phase current is sent out over feeder circuits that run to low-pressure distribution systems in adjoining towns. In this way

the towns of East Hartford, West Hartford and Wethersfield are supplied at distances of five or more miles from the generating station.

At Providence there is another excellent illustration of an electric system that supplies numerous and distant surrounding towns from a large steam power station in the city.

From the generating station on the water front in Providence the ten outlying towns and cities that are supplied with electrical energy include East Providence, Barrington, Warren and Bristol on the east side and Johnston, Cranston, Warwick, Coventry, East Greenwich and North Kingston on the west side of Narragansett Bay. These cities and towns extend entirely across the State of Rhode Island, a distance of about 27 miles, and north and south along the shores of Narragansett Bay for as much as 22 miles. In the cities and towns that are nearer to Providence electrical energy is distributed at 2,200 volts, 60 cycles, single-phase, by circuits that ran directly from the generating station there. For the distribution of service in the more distant places two sub-stations have been established, one in Warren and the other in Warwick. Each of these sub-stations is distant approximately ten miles from the generating plant in Providence, and energy is transmitted to them at about 11,000 volts, 60 cycles, three-phase. In order to obtain this pressure for the transmission lines transformers are used at the main plant to raise the 2,200-volt current from the generators to 11,000 volts. The transmission line to each of these sub-stations consists of rubber-insulated, lead-covered cable laid in tile conduits for a distance of about two miles from the generating station. From the end of its underground cable the line to the Warwick sub-station is carried overhead on wooden poles. On the line to the Warren sub-station an armored cable 800 ft. long that passes under the Seekonk River connects the underground with the overhead portion of the circuit.

At each sub-station the 11,000-volt current is reduced in pressure to 2,200 volts by transformers for the distribution circuits. Constant-current transformers are also located at each sub-station for the operation of 6.6-amp. series circuits for arc lamps, and these transformers draw their energy from the 2,200-volt bus-bars there. The arc lamps operated by these transformers are all of the enclosed type.

As may be seen from the foregoing, there is a decided tendency toward the transfer of electric loads in small places to the steam power stations of large distant cities, because of the advantages of the development of electric energy on a great scale. In this way the transmission lines approach each other. Lowell, Lawrence, Haverhill and Newburyport, the Massachusetts cities along which the Merrimac River, already supply most of the electric lighting in towns that border its banks. With electrical supply from the Boston L Street station as far north as Woburn, and current from the Lowell plant as far south as Billerica, only one town, that of Burlington, intervenes between the circuits of these two steam power stations, which are about 24 miles apart. On the west Worcester is little more than 40 miles in a direct line from Boston, and the transmission lines from this latter city have already reached Ashland about 25 miles on the way. The time will probably be short before the circuits from one or the other of these large cities span the remaining 15 miles between them. In Canton the lines of the Boston Edison Company have traversed 15 of the 44 miles between that city and Providence, and there is no large generating station along the remainder of the distance.

In Bristol and North Kingston the lines from Providence are within ten miles of the steam turbine station at Newport, and it needs little gift of prophecy to see that the former rival capitals of Rhode Island are destined to furnish electric light for almost the entire State.

Another factor, the transmission of energy from water powers to a number of distant cities and towns in each case, is tending to bring scattered electric loads onto a comparatively few great systems. Perhaps the most striking example of this sort in New England is the forty-mile transmission from the isolated generating plant of 6,000-kw capacity on the Housatonic River, in Kent, Conn., to Cheshire, New Britain, Waterbury and intermediate places.

WATER POWER IN NEW ENGLAND ELECTRIC STATIONS.

During the first decade of electric lighting water power was little used in the stations of New England. In 1890 only six electric stations in Massachusetts, those at Holyoke, Leicester, Middleboro, Turner's Falls, North Attleboro and Lee were using water power, and the total capacity of all their wheels was only 685 hp. At Hartford, Conn., the first energy developed by water power was received from the Poquanock plant by a transmission of eleven miles, in 1891. It was about 1893 before the power of falls on the Winooski River several miles from the business center of Burlington, Vt., were utilized to operate the electric system in that city.

Manchester, N. H., is literally surrounded by water powers besides having a large fall near its center, but the first independent electric station built there, about 1886, was driven entirely by steam power.

FIG. 9.—EXTERIOR OF POWER HOUSE, CONCORD, N. H., WATER POWER PLANT.

The first electric lighting at Manchester was done with water power rented from the Amoskeag Manufacturing Company in 1882, but this power was abandoned when the plant was moved to the Brook Street station in 1886. It was not until 1890 that an electric station for the use of water power was built, and this station was located at Kelley's Falls, about three miles from the business section of the city on the Piscataquog River.

At Concord, N. H., on the Merrimac River, the steam-driven electric station was abandoned in 1892, and electrical supply there has since been drawn from the water power at Sewall's Falls, about four miles up stream from the business center of the city.

In Maine the great abundance of water power led to its early use in some of the electrical supply systems. At Lewiston and Auburn,

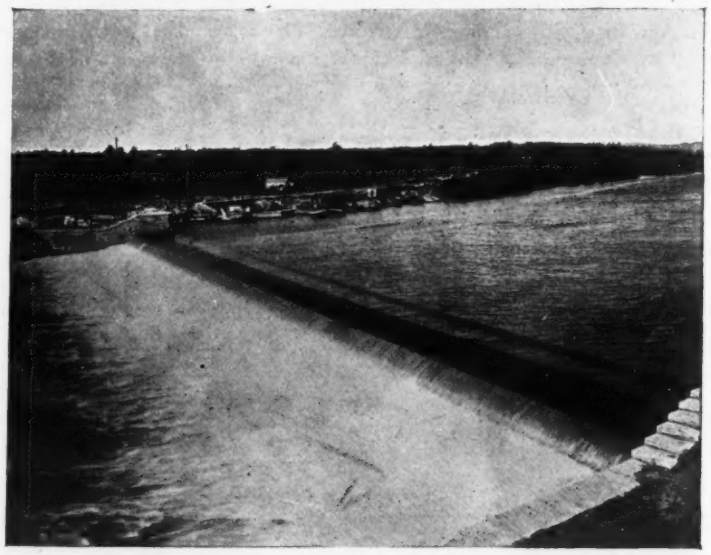


FIG. 10.—DAM AT SEWELL'S FALLS, N. H.

Me., cities that are separated only by the narrow Androscoggin River, and are a unit from a business standpoint, electric lighting seems to have been done with water power from the start, and four early water-driven stations are still in operation there pending the completion of a large modern plant about three miles up the river. Portland, the largest city of the State, depended on steam power for electric lighting up to 1898, though there are a number of undeveloped water falls within twenty miles of the business center, and one of the systems there still operates entirely with steam.

Several causes have combined to postpone the application of water power to the second decade of electrical supply. One of these causes is the idea, not yet entirely outgrown, that electric generating stations must be placed as close as possible to their loads. This idea had its only substantial foundation in the limitations of 110 and 220-volt

FIG. 11.—DAM, LEWISTON AND AUBURN, ME., PLANT.

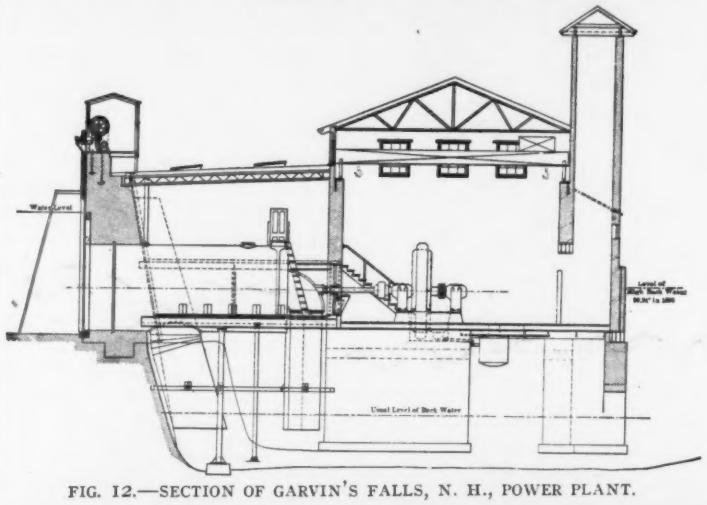


FIG. 12.—SECTION OF GARVIN'S FALLS, N. H., POWER PLANT.

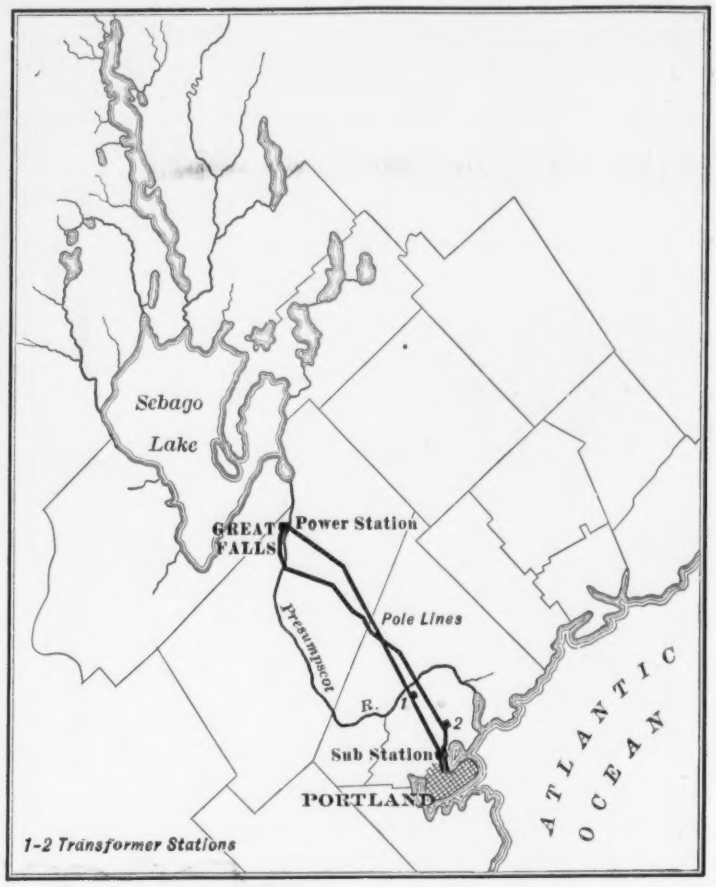


FIG. 13.—MAP OF PORTLAND, ME., TRANSMISSION LINES.

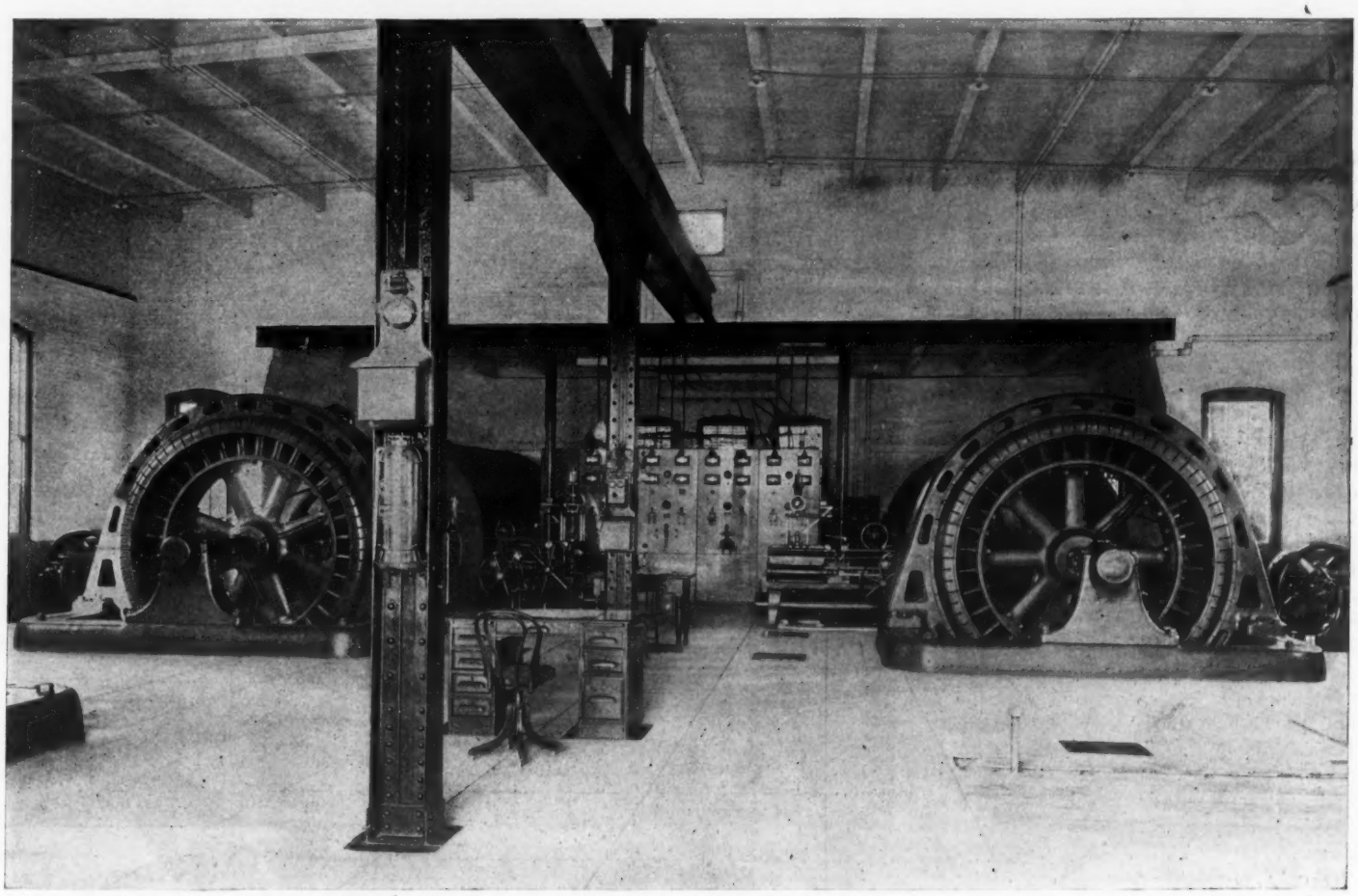


FIG. 14.—GREAT FALLS, ME., GENERATING PLANT.

direct-current service, and even here the necessity for a short radius of distribution applies to the sub-station rather than to the generating plant. With arc dynamos that ranged from 2,500 to 3,500 volts, and with alternating generators of 2,000 volts, a generating station might have been located five to ten miles from its connected load in order to utilize water power. Even with the moderate voltages just named available for such a short transmission, sub-stations might have been installed for service with direct current at 110, 220 or 500 volts near centers of distribution. But the transmission idea had not yet gained headway, and what many engineers knew as matter of theory, but few were ready to put into practice. Probably the strongest reason for the delay in the application of water power to electrical supply was the failure to fully appreciate its advantages. A saving in the cost of fuel was long regarded as the chief advantage of water power, and the large possible reduction in the labor of operation was in large measure overlooked.

FIG. 15.—GARVIN'S FALLS, N. H., POWER PLANT.

If water power was too much neglected in the first half of the period that covers the rise of electric lighting, the mistake is being rapidly corrected. In contrast with the four electric stations in Massachusetts that used water power in 1889, the number of systems operating with this power in 1903 was eighteen. While the combined capacity of all the water wheels in the electric stations of Massachusetts was only 545 hp in 1889, the year of 1903 found wheels of 10,334 hp so used among the electric water power system of Massachusetts as those of those of Springfield, Holyoke and Lawrence. In Maine more than a score of lighting systems utilize water power, including Augusta, Waterville and Bangor. New Hampshire, like Maine, depends largely on water power for electrical supply, and many of the smaller places as well as Concord and Manchester are lighted from this source. Besides Burlington, the largest city in the State, Montpelier, Bennington, Bellows Falls and numerous other places in Vermont are supplied with electrical energy from water power. Hartford afforded for some years the only prominent example of electrical supply from water power in Connecticut, but recently Waterbury, Cheshire and New Britain have begun to draw energy from an electric station on the Housatonic River.

The distances over which water power is electrically transmitted in New England are as a rule moderate. At Bangor, Me., the electrical supply comes from a station five miles up the Penobscot River at a point in the town of Veazie, where a dam is located. The great electric water power station on the Androscoggin that is being constructed for the supply of Lewiston and Auburn, Me., is only three miles up stream from the business center of these cities. To reach Portland, Me., the electric energy developed at Great Falls on the Presumpscat River is transmitted about fourteen miles. Of the four water-power plants that develop electric energy for Manchester, N. H., one is four miles, one six miles, one ten miles, and one fourteen miles from the sub-station in that city. Of the two water-power plants that generate electric current for the Springfield, Mass., system, the more distant is about six miles and the other about 5.5 miles from the sub-station near the business center.

Of the two water powers that supply energy to the electric system in Hartford, Conn., that at Poquonnoc is eleven miles, and that at Tariffville, thirteen miles from the city sub-station. Probably the longest transmission in New England, between a water power station and a city that it serves, is that extending from the electric plant near Bulls Ridge on the Housatonic River, in the town of Kent, Conn., to a sub-station in New Britain, a distance of about thirty-eight miles in an air line, and probably more than forty miles by the transmission circuit. This water power plant and rather long transmission system is owned by the New Milford Power Company, and the energy is to be used on the extensive system of the Connecticut Railway and Lighting Company, especially at Waterbury, New Britain and Cheshire.

FIG. 16.—GREAT FALLS, ME., WATER POWER PLANT.

As might be expected, the rather short electric transmissions of New England have not led to the use of extremely high voltages.

The line between Great Falls and Portland operates at about 10,000 volts, and the same is true of the transmission circuits entering Manchester and Hartford. Probably the highest transmission voltage in New England is that of 33,000 on the line above mentioned from Kent, Conn., to Waterbury, New Britain and Cheshire. The four transmission systems just named, and also most of the smaller ones throughout the same territory, operate with sixty-cycle, three-phase current. Where the line voltage is not more than 10,000 to 12,000, which is true for the great majority of transmissions, the more common practice is to develop this voltage in the generator windings and thus avoid the use of step-up transformers. This practice as to the equality of generator and line voltages exists in the Lewiston, Portland, Manchester and Springfield systems, but the contrary is true for Hartford and Kent. At both of the Farmington River plants that develop electric energy for Hartford the voltage of the main generators is 500 two-phase, and this is increased to 10,000 volts, three-phase by step-up transformers.

The generators just installed at the Bulls Bridge plant in Kent are rated at 1,150 volts each, and the transformers increase this pressure to 33,000 volts. Electric water power stations of New England are more notable for their numbers than for their individual capacities, but there are a few of these plants that compare favorably in size with the great majority of similar plants in other parts of the country. At the Great Falls plant whence energy is transmitted to Portland the capacity of each of the three-phase, 60-cycle generators is 500 kw, giving a total capacity of 2,000 kw for the plant. In the Springfield system the combined capacity of generators at the Indian Orchard plant is somewhat more than 2,000 kw, and the two 60-cycle, two-phase, 6,000-volt generators at Birchem Bend are rated at 400 kw each, so that these two water power stations have a generating capacity of fully 2,800 kw. At one of the Farmington River stations of the Hartford system, that at Poquonnoc, each of the two generators is rated at 600 kw, and the Tariffville system has two 750-kw generators, so that this system can draw 2,700 from water power, or very nearly the rated output of the two water-driven stations of the Springfield system. The Winooski plant that supplies light and power for the city of Burlington has a generator capacity of 1,080 kw, made up of three 2,300-volt, 60-cycle, three-phase alternators and six series arc dynamos. The Concord, N. H., system has a capacity of 1,000 kw in its generators at Sewall's Falls, this capacity being made up by five 2,600-volt, 60-cycle, three-phase alternators, and two arc dynamos.

An unusual feature of the Manchester system in the same state is the delivery of energy from four water powers to the same set of brushes at the sub-station in that city. At three of these water powers, Kelley's Falls, Gregg's Falls and Hooksett, the capacities, all in alternating generators, are 930 kw, 1,200 and 600 kw respectively. The fourth water-power station, that at Garvin's Falls, formerly contained only two generators each rated at 650 kw, sixty-cycle, three-phase, but a new dam and canal, together with a large extension of this plant have been in process of construction for the past year; this extension is designed to give the plant six generators of the type and capacity just named. These six generators will have a combined capacity of 3,900 kw, and this with the 2,730 kw of the other three plants will raise the rating of water-driven generators in the system to 6,630 kw. This capacity of water-power stations is greater than that possessed by any other electrical supply system in New England. Probably the largest generating capacity of any one station devoted to electrical supply is that of 6,000 kw in the new plant at Kent, Conn. This capacity is made up of six equal, three-phase, sixty-cycle generators, each of which is direct connected to a pair of horizontal turbine wheels. These generators operate at 1,150 volts, and six transformers are used to raise this pressure to 33,500 volts for the transmission line. Even the capacity just mentioned will be exceeded at the new water power plant above Lewiston and Auburn on the Androscoggin, which when completed will contain ten generators of 750 kw each. All of these generators will be three-phase, sixty-cycle, 10,000-volt machines, and each will be driven by a pair of direct-connected, horizontal turbine wheels. The generator capacity of this plant on the Androscoggin will thus just equal that of the celebrated station of 7,500 kw at Canon Ferry on the Missouri River, and will exceed the capacity of any of the famous water-power stations in California save that of 10,000 at Electra, and that of 11,250 kw rating at Colgate.

Unlike these notable California systems the electric water power stations of New England have to deal, as a rule, with rather low heads of water. At the Indian Orchard and Birchem Bend stations of the Springfield, Mass., system, the heads of water are 36

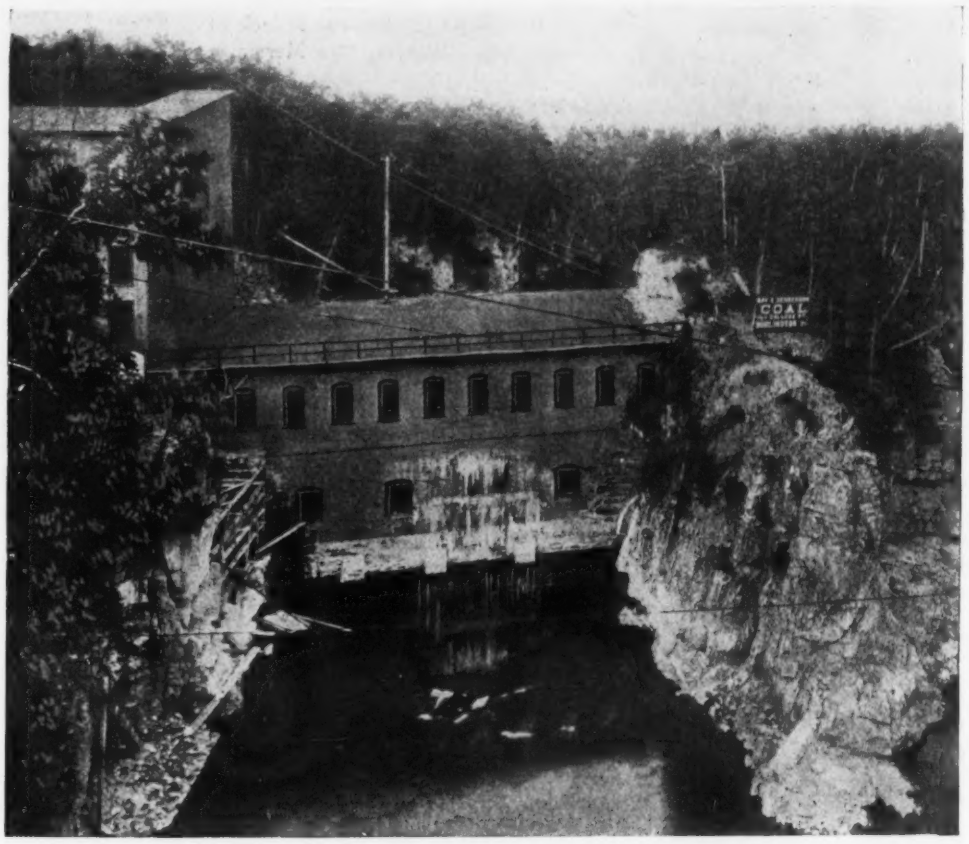


FIG. 17.—BURLINGTON, VT., WATER POWER PLANT.

and 14 ft. respectively. At the Burlington, Vt., station the wheels work under a water pressure of 31 ft. Sewell's Falls, on the Merrimac River, afford a head of 15 ft. for the wheels that drive the generators of the Concord, N. H., system. Several miles down stream comes Garvin's Falls, with a head of 30 ft. that will be maintained by the massive stone dam now under construction, and still further down toward Manchester are the 16-ft. falls at Hooksett, both of which develop energy for distribution in that city. On the Piscataquog River, which joins the Merrimac at Manchester, are Kelly's Falls of 24 ft., and Gregg's Falls of 51 ft., both of which develop energy for the city last named.

To develop 10,000 horse power in the new station above Lewiston, Me., a fall of 32 ft. in the Androscoggin will be maintained by the new concrete dam. At Great Falls the generators that develop electric current for distribution in Portland are driven by wheels that work under a head of 37 ft. The stations on the Farmington River that develop energy for distribution in Hartford operate with water heads of 23 and 32 ft. respectively, the earlier plant having the greater, and the later, or Tariffville, plant the lesser head of water. At the 6,000-kw station in Kent, Conn., the largest now driven by water power in New England, the greatest head of water, that of 115 ft., is also found. It is worth noting that the greatest station capacity, the largest head of water, the highest voltage, and the longest transmission in the entire territory under consideration are to be found in the system of which the plant just named forms a part.

All of the water power stations above mentioned, and most if not

all of the smaller ones in the same states, are equipped with turbine wheels. In all of the recent plants the turbines are of the horizontal type, and are direct connected to the generators. At some of the older and smaller stations the turbine wheels, though horizontal, are belted to one or more shafts that in turn drive the generators, through belt connections, as is done in the Burlington plant. In other cases, as at the station of the Concord system, each pair or set of horizontal turbines is belted to a single generator. The old type of connection in which vertical turbines are geared to a horizontal shaft, and this shaft is belted to the generators, is being generally abandoned though still in use at a few of the older and smaller stations. Storage of water for use at electric stations has not received the attention that it deserves, but some of the plants are well situated in this respect.

Above the Burlington plant on the Winooski the dam forms a pond three miles long, and during more than ten years of operation the use of steam has been necessary on only two days because of lack of water. The new stone dam at Garvin's Falls on the Merrimac River sets back the water to a distance of several miles up stream. In the great upland bogs of Brookfield the water is held as in a sponge, and the Chicopee River which rises there has a remarkably constant and even flow, so that the stations at Indian Orchard and Birchem Bend generate more than 90 per cent. of the entire output of electrical energy in the Springfield system. Although the Farmington River has a rapid descent, and the facilities for the storage of its water are far from what could be desired, only 1,009,598 kw hours out a total of 8,577,699 kw hours distributed by the Hartford system during the calendar year of 1901 was derived from steam power. In other words, water power furnished 88.2 per cent. of the energy output of the system in that year.

In Concord, N. H., the average week-day output of the electric system was about 6,800 kw hours during the year ending June 30, 1901, and the total rated capacity of all lamps and motors connected to the system was 1,850 kilowatts approximately. In this same year only about 500 tons of coal were consumed in the operation of the Concord system, and the water power at Sewall's Falls did the remainder of the work. Few, if any, water powers in New England are more constant than those along the Presumpscot River, which forms the only outlet of Sebago Lake. This lake has an area of fifty square miles, and a drainage of 470 square miles, so that each square mile of the lake area receives drainage from less than ten square miles of territory, on an average. A result is that records extending over more than ten years show a maximum variation of only 5.75 feet in the lake levels. A dam at the outlet of this lake regulates the height and flow of water, and gives it exceptional value as a reservoir. Besides the storage between wet and dry seasons afforded by this lake, the station at Great Falls has a pond behind its dam that is about one mile long, 1,000 feet wide, and 15 ft. deep, the Portland electrical supply system. During the year 1903 not a pound of coal was burned by the Portland system.

The electric systems centering at Lewiston, Portland, Burlington, Concord, Manchester, Lawrence, Holyoke, Springfield, Hartford and Waterbury will have generators of 31,674 kw total capacity connected to water-wheels in their stations, when the plants now under construction at Lewiston and Garvin's Falls are completed. As there are eighteen electric stations using water power in Massachusetts, and more than twenty such stations in Maine, the total capacity of generators driven by water power in the electrical supply systems of New England is probably between 40,000 and 50,000 kw.

With all this, the development and transmission of water powers is still in its early stages, and another twenty years of electric lighting will see the greater amount of energy used in supply systems drawn from the rivers of New England.

Electrical Standardizing Bureau for Canada.

A deputation of Canadian electrical interests has waited upon the Minister of Inland Revenue asking that the government establish an electrical standardizing bureau, to be maintained independent of any other branch of the public service, and placed in charge of a qualified electrical expert, at whose disposal should be placed trained assistants and proper facilities. The delegation also asked that the law be amended so that if any device was found in the possession of any one to prevent the proper registration of electric current, it should be prima facie evidence for his prosecution and conviction.

Report of St. Louis Railway Test Commission.

A full meeting of the executive committee, appointed to determine the nature and scope of the electric railway tests to be made at St. Louis and elsewhere during the coming summer, was held at St. Louis on Friday and Saturday, May 6 and 7. The committee consists of Prof. W. E. Goldsborough, chief of the Department of Electricity, Universal Exposition, chairman; Prof. H. H. Norris, Cornell University, superintendent of electric railway tests, and Profs. B. V. Swenson, University of Wisconsin, and H. T. Plumb, Purdue University, assistant superintendents of electric railway tests. After careful study of the reports of the engineering committees of the suggestions of the advisory committee, and of the excellent facilities afforded by the Exposition officials, the executive committee decided to undertake the following series of tests:

(*a*) Tests on the service capacities of electric railway motors. Equipments will be operated upon the special tracks at different rates and durations of acceleration, coasting and braking, with different lengths of stops, in order to determine the heating of the motors under conditions approaching as nearly as possible those of commercial practice. The motors will also be tested separately for heating and for the determination of their torque curves and accelerating power. This will render possible the comparison of the performance of the same equipment upon the track and test stand.

(*b*) Acceleration tests. Acceleration tests upon single cars and upon multiple equipped trains will be made to determine the ability of the equipment to bring the cars to speed quickly and economically.

(*c*) Braking tests. Braking tests upon single cars and multiple equipped trains will be conducted in order to determine the quickness of action, the shapes of the braking curves, the relation between the braking forces and the applied pressures and the best methods of application of the braking forces.

(*d*) Tests upon train resistance. Determinations of the resistances due to the rails, to the journals and gearing and to the air will be made by systematic and complete series of runs. The effect of the shape of the car body will be carefully investigated. The methods to be used in measuring train resistance comprise the use of calibrated motors as the sources of power, the hauling of the car under test by calibrated dynamometers, and by noting the falling off in speed while the cars are coasting. The pressure of the air upon different parts of the car will be recorded by means of self-registering pressure gauges. In addition to this definite series, a number of other tests will be conducted upon various exhibits in the Palace of Electricity in order to determine their efficiency and reliability.

Sections (*a*), (*b*) and (*c*) of the tests will be carried on upon the tracks which have been built for the purpose by the Exposition. These are of substantial construction, conveniently located, and of a total length of about 4,500 ft. For the tests described under section (*d*) the Indiana Union Traction Company has provided a stretch of eight miles of straight and heavily ballasted track. The resistance tests will be made after the completion of the programme.

In all of the above work, graphical records of the measurements will be obtained by the use of autographic instruments which will be either built for the purpose or supplied through the co-operation of the manufacturing and operating companies and the technical colleges. The National Bureau of Standards will materially aid in this work by providing facilities for the calibration of all of the instruments. For the purpose of comparison, the various railway equipments will be divided into several classes, including car weights up to forty-five tons, as follows: (*a*) Light city service equipments, (*b*) heavy city service equipments, (*c*) light interurban service equipments, (*d*) heavy interurban service equipments.

The actual work of observation and calculation will be carried on under the personal supervision of the superintendents by a corps of young men carefully selected from among the graduates of leading technical schools, the total number of observers being between thirty and forty. The Exposition management is co-operating enthusiastically with the railway test commission in providing ample facilities for the tests and substantial results of permanent value to the profession are confidently expected.

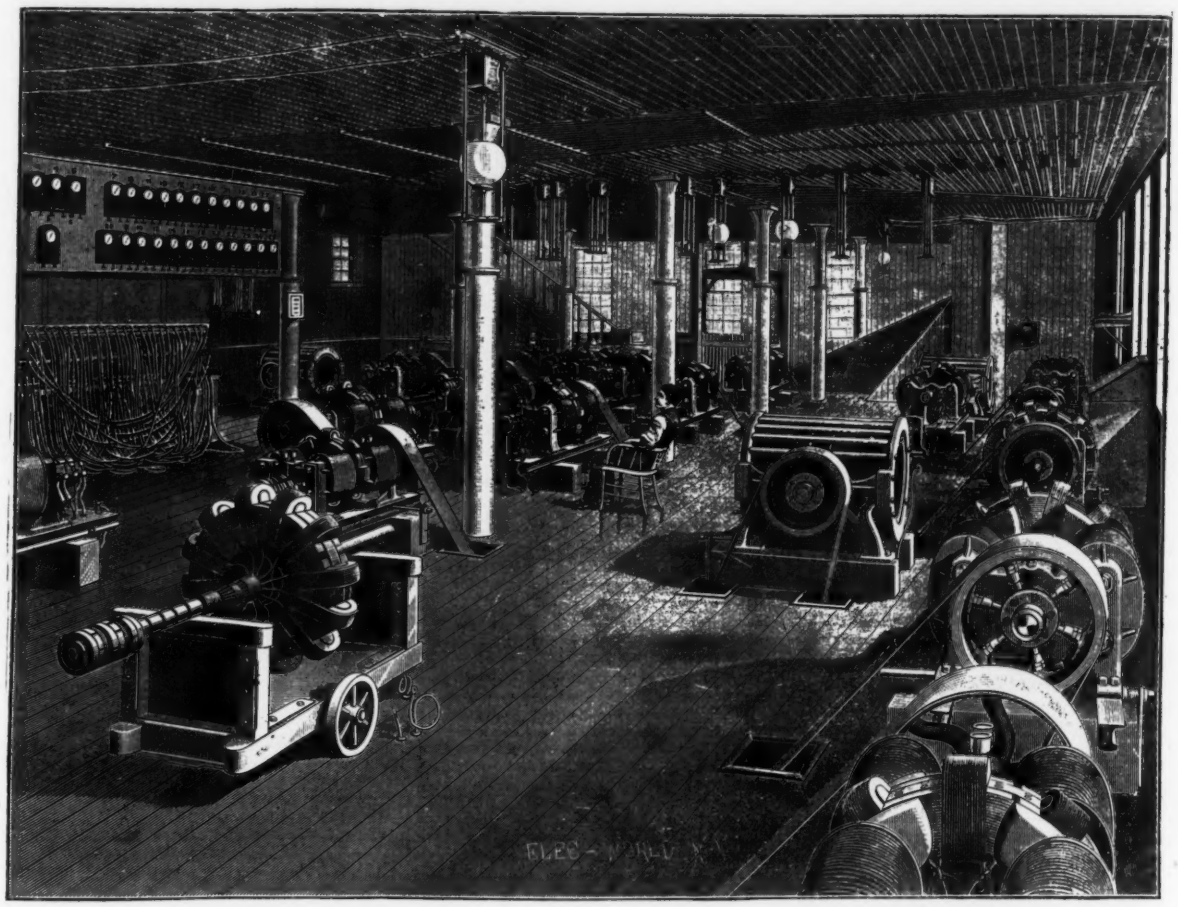
At the present time a large part of the equipment is already at St. Louis, the organization is complete, and the ranks of the testing corps have been filled with earnest young men.

The Boston Electric Light Convention of 1887.

IT is seventeen years since the National Electric Light Association visited the city of Boston, although the electrical development there has been such as to justify a more frequent return. So much electrical history has been written since 1887 it has occurred to us that many readers of the ELECTRICAL WORLD AND ENGINEER would like to refresh their memories in regard to what was done by the Association on the occasion of its previous visit; while those who have entered the field of electric light and power since that time will also be put more closely in touch with its evolution and development, by the present brief retrospective sketch. Neither the art nor the Association was very old at the time referred to, and to all except those gifted with prophetic minds the present close harmony and alliance between the arc lighting and incandescent lighting branches of the industry then seemed impossible. In fact the tendencies which have made electric lighting one art instead of two were already at work, but were not fully recognized. Aside from the inevitable trend of financial and commercial interests towards consolidation there were two agents beginning to make themselves felt, to which alone might be attributed almost entirely the present status of the art and the industry, namely the adoption of the alternating current and the introduction of the direct-current motor. It is sharply within the memory of veterans who attended the Boston convention seventeen years ago that the impressive feature of that affair was the large exhibit made of direct-current motors, although singularly enough these were designed for arc lighting circuits, to be operated in series, rather than for the incandescent circuits to be operated in parallel, as virtually all motors are to-day. The same year, 1887, was a landmark also as being the time when Tesla came to the front and changed the whole aspect of things with his polyphase inventions and motors.

In connection with the visit to Boston the ELECTRICAL WORLD AND ENGINEER of that day presented to its readers an elaborate wood cut engraving which we are emboldened here to reproduce for its historical interest, showing the interior of the Ferdinand Street station of the Boston Electric Light Company—one of the four stations then under the management of the late F. A. Gilbert. The dynamo room here shown—one of three floors—contained 16 Brush arc dynamos of 65-light capacity, and 7 of 30-light capacity, two Thomson-Houston arc machines of 30 lights, and one of 50-light capacity. This gave the station a total capacity of 1,360 lights, all of which were in use. With regard to electric lighting in general in Boston at the time of the last convention, it is rather difficult to give the exact figures, but the arc lighting system at that time had apparently a station capacity of about 3,000 arcs and in 1888-9 had 2,171 in service. At the end of 1887, the Boston Edison Company had connected on its three-wire system an equivalent of 8,380 incandescent lamps of 16 cp and about 80 motors of an aggregate of 300 hp. All these various services being now consolidated under the management of Mr. C. L. Edgar, the growth since that time can be summarized by stating that the Boston Edison Company at the beginning of May, 1904, was operating 642,406 incandescent lamps, 9,546 arcs and 23,891 hp of motors. Our readers can see for themselves at a glance how manifold has been the increase.

The convention of 1887 was called together by President J. Frank Morrison, at the Parker House on August 9, and the list of those in attendance revives memories of men who did valuable work in the development of the industry, and have passed away. Mr. Morrison, in his address, called attention to the development of the alternating-current system, then in its infancy, but, strangely, his remarks did not include anything about electric motors—possibly for the disinterested reason that he was devoting a great deal of his remarkable personal energy to their introduction. An interesting report was made by the legal committee on the "Status of the Patent System," signed by Messrs. J. F. Morrison, Frank Ridlon, Walter C. Kerr, Frank J. Sprague and A. Steuart. This is a rather striking group of names, and it is pretty safe to say that the gentlemen have never been associated technically since. Dr. A. V. Garratt then presented an extremely interesting and valuable report on "Wire Gauge," which he accompanied by an elaborate table, the calculations in which were made by himself and Messrs. H. H. Eustis and P. Keilholtz. A further interesting report on the subject of wire was that of the Committee on Insulation, consisting of Prof. E. J. Houston, W. D. Marks, Carl Hering and M. M. Garver. The report was an admirable document and most of its ideas and recommendations have now become part of the art; in fact, the National Code may be said to have here had its beginnings.



BRUSH LIGHTING PLANT, FERDINAND STREET, BOSTON, 1887. (*From a Wood Cut in The Electrical World.*)

The subject of alternating current came up again in the report or paper read by Mr. M. M. Slattery, so well remembered from his connection with the subject in the early days of the Fort Wayne Company. The wonderful development of the system since that time has justified the advanced stand then taken by this lamented pioneer—with perhaps one point of difference, that whereas he urged that the adoption of the alternating system with its smaller wires would release the companies from the attacks then waging on overhead wires, it may be said that modern central station polyphase work has been one of the greatest compelling causes for undergrounding the circuits.

Mr. E. R. Weeks, of Kansas City, now a past president of the Association, presented a thoughtful paper on "Electrical Education," and here again one finds the keynote of progress struck. Aside from the better education of engineers and employees and the establishment of mutual improvement societies amongst the men, Mr. Weeks advocated examinations by municipalities as to the competence of men engaged in electrical occupations, since the safety of life and property in growing degree depended upon their faithful and intelligent work.

Lieut. J. B. Murdock, at the beginning of the second day—when the convention was called to order by Mr. Ralph W. Pope—read a valuable paper on "Electric Lighting for the New Cruisers." We are now familiar with the idea of the new navy, but at that time it was not a "fleet in being," nor were marine lighting methods very well developed; and this paper summarized all that had been done and most of what was known up to that time. There is perhaps no particular reason why the Association to-day should not still consider such subjects, but it is the fact that of late years it has pretty well discontinued all discussion of work connected with isolated plants, except so far as such plants come in competition with central stations. To this extent the Association has narrowed its functions, so that papers read on the subject of isolated plants are to be expected before bodies like the American Institute of Electrical Engineers, or the New York Electrical Society. The Association can well assert that the greater magnitude of the industry to-day gives it subjects enough for treatment without going beyond the central station borders. It may be noted in this connection that at the meeting a large part of the time, as usual, was taken up with a discussion on the new constitution. In those days the constitution was a burning question, because one or two pretty palpable efforts were made, by men with more daring than judgment, to capture the machinery of the Association in order to promote certain objects which were hardly calculated to enhance the usefulness of the organization; and for some few years the proceedings of the body were considerably enlivened by this kind of politics. Fortunately, for some time past the Association has been able to give its attention strictly to the treatment of the technical and commercial questions in which it is broadly interested.

One of the most important features of the proceedings was that dealing with storage batteries. Mr. C. O. Mailloux read a masterly paper on the "Status of the Battery," and justified, as he has always done, his strenuous advocacy of that useful implement. And while it has not realized all the hopes of its friends in connection with traction work, it has certainly proved of immense value in connection with electric lighting. Though some of those present may have thought that Mr. Mailloux overstrained his statement of the case in this respect, subsequent events are all that Mr. Mailloux needs to point to for vindication. A melancholy interest attends the other paper on storage batteries, which was submitted by the late Mr. Anthony Reckenzaun, and which dealt specifically with batteries for electric locomotion. This brilliant young engineer, whose loss was so keenly felt on both sides of the Atlantic, made a modest presentation of a great deal of his own work, creating a highly favorable impression. But it is melancholy to reflect that, although we have now hundreds of electric automobiles in operation, there is probably not a single storage battery car turning its wheels today in the United States. In connection with this paper, the subject of electric motors came up and was interestingly discussed, but incidentally let us note that the subject of the stationary power motor was passed over almost without a word of reference, apparently because the versatile Mr. Sam Duncan, of Pittsburg, thought it better to turn in the documents in regard to that item to the Executive Committee. This, however, was redressed largely by the splendid exhibit of Baxter motors made at the hotel.

The last item on the programme was a discussion of "Underground Wires," in regard to which there was a sharp little discussion, and then Mr. Duncan touched on a delicate matter in calling attention to "pools" which had been formed on arc light carbons. This gentleman remarked that if the arc light men had got to break down such a pool every two months they ought to be in shape to do it. The result was that a committee of three was appointed to deal with the matter. We should hardly like the job of compiling a list of all the pools which have been formed in the electric lighting field since that time, some of which have succeeded, and others of which were badly "busted." A few could be mentioned which are understood to have a lively and healthy existence at the present time.

Part of the convention was a very fine exhibit of electrical apparatus, including several scores of exhibitors. This feature of the convention is still maintained, although hardly with the vigor and magnitude of earlier years, since apparatus is now standardized, and people are tolerably familiar with it. The great feature of the outside exercises, however, was the trip given to about 250 of those present by the old Thomson-Houston Company. The excursion included a trip on a steamer, a visit to the Thomson-Houston works at Lynn—where were found Prof. Thomson and E. W. Rice, Jr., and A. L. Rohrer—and a banquet at the Point of Pines. The factories, at that time as now, under the direction of Mr. C. A. Coffin, embraced about 80,000 sq. ft. of floor space, and the main item in connection with them was that they turned out 300 arc lamps weekly. Mr. Coffin's report for the General Electric Company this year, 1903-4, shows a floor space for the General Electric Company of 3,700,000 sq. ft., and 17,000 employees. The Lynn works alone during the past year have had an increase to their buildings of over 300,000 sq. ft. The banquet down by the seashore that night was a remarkably interesting affair, and was signalized by the fact that Mr. Coffin so far forgot his wonted reticence as to make quite a long speech, which was couched in felicitous terms, included two or three good stories and evoked thunders of applause. The response and recognition in behalf of the Association to this hospitality and to Mr. Coffin personally were not only due and appropriate; but, in view of the intimate intertwining of the relationships between the great manufacturing company and the electric lighting art, which has continued from that day to this, the record does one good to read and recall these seventeen years later. In fact, this brief review which touches only the salient points of a busy week, may serve to bring up in the minds of our readers some reminiscences of other events worthy to be gone over again by the survivors of a memorable convention.

"Let the Trolley Lights be Burning."

In the future we may hear of trolley cars as lifeboats. An ingenious use of a car and its arc headlight was recently made at Redondo, Cal., on the Pacific Coast. A lumber schooner anchored off the beach broke her chains at night and was blown on to the lee shore. Efforts were immediately made to rescue the men, and one of the interurban cars of the Los Angeles & Redondo Railway Company was run to a point whence the beams of its headlight could be thrown on the vessel. In this manner assurance of help was given to the crew of the boat and the light aided the rescuers in getting a life line to them. Probably we shall now hear of English bathing machines available as trolley cars by day along the beach and as lighthouses by night. These machines anyhow could be hauled up and down by motors, and could light up the esplanade at night.

Radium "Mother Ore."

The *Neue Wiener Tageblatt*, Vienna, reports that at a meeting of the Mineralogical Society Dr. F. J. Becke spoke of uranium pitchblende ore, the mother ore of radium. Prof. Becke, jointly with Prof. Suess, has made very searching investigations at Joachimsthal, the place where uranium is mined. It occurs mainly in mica slate, in the deep workings of the former levels of the silver mines of Joachimsthal. He mentioned the experiments which were made with uranium pitchblende ores at the Imperial Museum of Natural History. These ores have been in possession of the museum since 1806. The experiments demonstrated that, in spite of their age, they have lost absolutely nothing of their intensity of radioactivity and of the energy of their electric properties. They do not differ in any way from the ores now taken at Joachimsthal.

A Resumé of Incandescent Electric Lamp Exhausting.

BY S. E. DOANE.

THE exhausting of incandescent electric lamps has developed into a highly specialized branch of the lamp manufacture. In order to crowd a description of the development of this portion of the art into the limits of one article, it will be necessary to abbreviate portions of this description considerably. The history of the art up to the development and adoption of the present chemical exhausting method will be passed over rapidly. The latter method will be considered as thoroughly as the allotted space will permit.

The first incandescent lamp of the modern type ever constructed was exhausted on a mercury pump. Mercury pumps were used for lamp exhausting for nearly twenty years before they were superceded by the present chemical process. These mercury pumps were of two general types. Each type had its advantages and disadvantages, but overshadowing all was the need for better brains than could be obtained for the attendance demanded by all mercury pumps.

Either type of pump required active, intelligent men of strong physique. Men with these three qualities were fitted for far more pleasant duties, so that the supply of such men was always far short of the demand. The result was that the pump rooms always contained many men who, while possessing some of these qualities, were not completely qualified for the exacting service. Many of those who were qualified, and who, for brief seasons, filled the hearts of the lamp manufacturers with joy and hope for the future, would be found after the first pay day to be confirmed drunkards. Drinking men seemed more numerous in the pump rooms than elsewhere. I can see, as I look back, that this was because we tolerated more of it in the pump rooms than elsewhere. We were thus obliged to put up with insufficient mental capacity on the part of strong, faithful workmen, accepting the widened voltage range, shortened life and decreased candle-hour performance of the lamps improperly exhausted, year after year, gradually improving our condition as we developed the processes. The changes and improvements did not essentially modify the general practice, which was as follows:

The mercury pumps used by all lamp manufacturers in this country, which commenced operation not later than about 1885, were of the Sprengel type. Many of the companies began about this date to change to the Geissler form of pumps. Companies starting at a later date without exception so far as the writer can learn, used the Geissler form. The reasons for this will appear as we discuss the faults of the Sprengel pumps.

The Sprengel pump consisted essentially of a stream of mercury falling through a glass tube. All systems of this class had the following good qualities and faults:

The pumps gave a good vacuum, were cheap, simple to construct and to repair. When a pump failed only one lamp was injured. Every lamp was individually exhausted, which insured its being exhausted at just the proper voltage, when conditions were uniform, providing the operator was competent. We were content to have a pump which would procure for us a good vacuum, when the business was young. It was some time before we awoke to the fact that there were other requirements.

As we discovered the various new requirements, we also discovered fundamental faults with our apparatus and methods. These faults were finally found to be so serious that so far as I can learn every company in the country but one abandoned the Sprengel form of pumps for the Geissler form before ultimately adopting the chemical exhausting process.

At least every third man in the pump room (the men worked in teams of three in the best developed system) had to be an expert. The men were much exposed to the poisonous fumes of the mercury. Their hands were almost always black with an amalgam of mercury and grease. Many men were incapacitated because of mercury poisoning, and as this became known it became more difficult to secure the requisite grade of intelligence.

The men were required to be on their feet all day, working almost constantly with their hands on a level with their shoulders, a blazing row of lamps in front of them and sometimes behind them. While every effort was made in summer to keep the pump rooms cool, air drafts were tabooed and there was no way of escaping the light and radiant heat from the lamps. Add to this the danger to health and it will be seen how difficult it was to obtain the kind of men required.

Pumps did not all work at the same speed. The glass tubes from which the pumps were made were of different diameters, which was one reason for the differing speeds. The cleanliness as well as the diameter of the principal glass tube of the pump affected its speed. The diameter of the hole in the glass tube attached to the lamp through which the air was exhausted also affected the speed. The differing speeds was a matter of much importance for the following reasons:

The completed lamp must not only be free from gases and vapors, but must also have had those parts capable of giving off gases and vapors, thoroughly freed from them. The only way we knew to accomplish this was to highly heat everything we wished to free from gas. We had three things to heat: the glass, the filaments and the joints between filaments and leading-in wires.

The glass was heated by an asbestos cone-shaped hood painted black on the inside. The heat from the lighted lamp furnished all the heat necessary. The lamps could be heated hot enough to cause the bulb to collapse if the hoods were made too thick. The filaments were also heated sufficiently by the current, but the joints were not heated sufficiently unless the current was passed through the lamps at a time when the gases were of just the right pressure to allow current to pass across the vacuous space from joint to joint. The current would not pass across this space, if the gas pressure was either too low or too high, and we had very little latitude in this respect. If we put sufficient voltage on the lamps to pass this current from joint to joint before the gas pressure in the lamps was sufficiently high, we burned the surface of the filaments. Filaments thus burned varied in color from light bronze to sooty black. If we waited too long and the gas pressure had been a little too much reduced, we could only pass this current from joint to joint by putting a destructively high voltage on the lamp, and if it had been too much reduced we could not heat the joints at all.

We found difficulty in making uniform filaments, which difficulty we still have, in a much reduced degree. This non-uniformity made it necessary for us to burn each lamp on these pumps at a different voltage, as at the same voltage a lower voltage lamp would get hotter than a higher voltage lamp and a hotter lamp would exhaust more quickly than one relatively cooler. Thus it will be seen, lamps were exhausted at various speeds for the reasons that (1) the pumps themselves were of different speeds; (2) the tubes through which we exhausted the lamps were contracted to slightly different diameters, and (3) the lamps were only exhausted at the same temperatures when the judgment of the operator was good.

The Geissler pump enabled us to get around these difficulties, but also introduced some of its own. The advantages were as follows:

1. The pumps were all of the same speed. 2. While the lamps were not exhausted through tubes any more uniform, the "slow" lamps being connected to the same reservoir as the "fast" lamps they balanced up fairly well, as we had twenty or more lamps on one reservoir. 3. We could not exhaust the lamps at so nearly the same filament temperature, but the conditions under which we exhausted made all the lamps of the same temperature of glass, and consequently of the same temperature and pressure of gas. This was because all the lamps on one Geissler pump were heated in one hood. This hood was raised to a high temperature by gas flames. We did not depend upon the filaments to produce the initial temperature which very much reduced the liability to burn the filaments.

In addition to these three important advantages we could keep all hoods at the same temperature, start all pumps simultaneously, give all pumps the same number of strokes, flash all lamps simultaneously, thoroughly protect the mercury from contact with the air, and we required only one high-grade man in the pump room, where formerly one-third of the operators had to be high-grade men.

We now felt that a great stride had been made in the exhaustion of incandescent lamps, but additional experience with the Geissler pump brought to light faults which still left much to be hoped for. The faults were as follows:

1. They were more expensive to operate, for the following reasons: (*a*) If one lamp leaked, the whole lot of lamps on this pump could not be exhausted. If the leak was only a small one, we would damage all the lamps on the pump. (*b*) The pumps were fragile, and if a lamp was accidentally broken, or if in any other way air was admitted accidentally, the pump was liable to be ruined. Lamps had to be more carefully inspected for leaks and glass work had to be more carefully done.

2. We still were unable to make lamps of exactly the same voltage. The lamps on one pump would necessarily have to be handled as a unit, which would mean that lamps designed for the same voltage would all have to be exhausted at the same voltage.

It became increasingly apparent as the effort was made to improve quality and reduce cost, that it would be strongly advisable if some means be found for individually exhausting lamps which did not possess the prohibitive faults of the Sprengel pump system. Some of the companies went so far as to construct some very small Geissler pumps to take one lamp each. It is hard to say what the outcome of this would have been, had not the chemical process been developed about this time.

The mechanical pump systems came into use about this time. All of them were open to the objections which held with the Geissler. Pump makers did not seem to appreciate the fact that whether a pump used mercury or not, it was simply and solely a pump. Some very good mechanical pumps were made, but most of them had a capacity greater than that of any Geissler pump. In order to get a reasonable output for the money invested, it was necessary to exhaust an even larger number of lamps simultaneously. This offered no escape from the troubles of the Geissler pump systems, and hence came into only limited use.

The chemical process was brought to us by a lamp maker. He knew the drawbacks of the mercury systems. This process possessed the advantages of the Sprengel system, the advantages of the Geissler pump system, and also some advantages of its own, without the conspicuous disadvantages of any of the previous systems.

While the Sprengel pump system only required that every third operator should be an expert, the chemical system required that every operator should be an expert, but it made it possible for us to secure experts, by entirely removing the disadvantages which made it so difficult for us to get a good class of operators. We found we had no difficulty nor do we now have any difficulty in securing plenty of young women of good intelligence who find the chemical exhausting work rather pleasant than otherwise. Every operator sits down to her work, has only one lamp on the pump at a time and is able to exhaust every lamp according to its individual requirements.

Two articles of any kind differ in some slight degree. This is true of incandescent lamps with special reference to the manner in which they exhaust. It may be that in one the joints between the filament and the platinum wires are larger or the joints are a little closer to the glass stem, or that the lamp has not been heated quite so hot in the preliminary heater or perhaps the bulb is of slightly different internal dimensions. Be the causes what they may, the differences are sufficiently marked to be quite apparent to the operators. This was all fully realized during the closing days of the mercury pump systems, but the vital difference this made to the candle-hour performance of the lamps has never been so fully appreciated as since we began to use the chemical process of exhausting. The chemical process of exhausting consists roughly of mechanically exhausting a heated lamp to a pressure represented by a column of mercury about .125 mm. high. This is equivalent to about 1/6000 of an atmosphere. The lamp is sealed off from the pump and phosphorous is vaporized and passes into the lamp bulb while the filament is very hot and while an electric current is passing through the gaseous contents of the bulb. The vapors of this metal enter into an electrochemical combination with the gases, forming solid precipitates, if the conditions are proper.

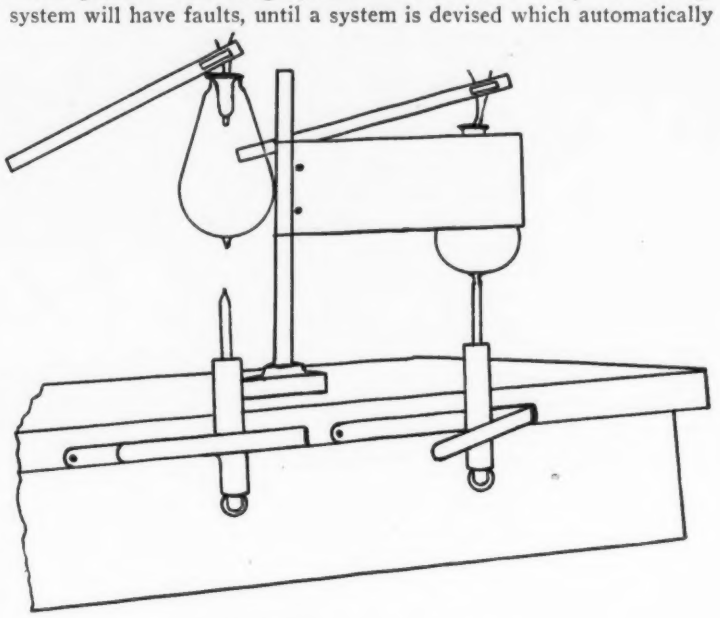
This whole operation from the time the lamp is first lighted up on the pump to the time it is completely exhausted requires approximately sixty seconds. During this time the following changes take place in the lamp bulb:

About one-half minute after the lamp is first placed upon the pump and before the lamp is shut off from the pump, current is passed through the filament. Current also passes from joint to joint across the vacuous space, heating both joints white hot. The joints are held at this temperature for a few seconds after which the current is reduced and the pump is given a few seconds to remove the gases which are dislodged by this heating. This takes about five seconds under usual conditions. The tube connecting the lamp to the pump is then closed very close to the lamp. The current is again increased until it again passes through the vacuous space from joint to joint. The first effect of this current flow is to again raise the temperature of the joints to a white heat. After about a second, without changing the voltage around the lamp, the blue flame which was playing between the joints, gradually expands, the color gradually changing from the first dark blue shade to a beautiful light blue, the joints meanwhile cooling somewhat. As soon as the lamp reaches this condition, the phosphorous which has previously been painted on the inside of the glass tube leading from the lamp is vaporized and the vapors passing into the lamp bulb react with the gases in the bulb, causing the blue to disappear. The effect of the sudden disappearance of the blue color is to make the lamp look very yellow. It is a common expression in the lamp factories to say relative to this portion of the exhausting process, that the lamp "turns yellow."

In order that the current may pass from joint to joint across the vacuous space the pump must necessarily produce a higher vacuum than is usual with mechanical pumps. The pump used in this work is of the ingenious variety which depends upon an oil-covered piston to displace all the air in the pump cylinder. The pump is so constructed that a little oil is always passing into the cylinder and is forced up through the exhaust valve with the gases which are being expelled. This oil is used over and over again. It is free from occluded gases, contains no volatile oils, and has a low surface tension. Care is taken to select an oil with these characteristics.

A mechanical pump of this description never produces a vacuum so high that there is any difficulty in passing current from joint to joint in the lamp being exhausted upon it. Care has to be taken with these pumps to be certain that they are always in such condition that they will produce a sufficient vacuum.

The present exhausting system has its faults. Any exhausting system will have faults, until a system is devised which automatically



CHEMICAL EXHAUSTION OF LAMPS.

keeps itself in repair and also automatically and perfectly exhausts lamps without the interposition of human judgment. The faults which concern us the most are as follows:

1. We must still have expert operators. 2. We still depend upon a system of pipes and valves which will occasionally develop leaks. 3. Pumps occasionally get out of order. 4. The chemical reactions which produce the vacuum are sensitive and atmospheric and chemical conditions occasionally give us new problems.

A better understanding of how this chemical exhausting is performed will be gained from the following description referring to the accompanying sketch. The operators are all seated in front of a long bench behind which are a number of little pumps. These pumps occupy about four feet of floor space and stand less than three feet high. They run continuously, being piped by the shortest possible connections to the face of the bench. Each operator utilizes one cylinder each of one of these pumps.

In the sketch the lamp on the left is exhausted and ready to be removed from its clip. The lamp on the right is shown thrust into a bit of rubber tubing. This tubing passes through a pinch cock on the edge of the bench.

In front of the lamp is a piece of metal that shields the eyes of the operator when the lamp is brightly lighted. The piece of metal can be swung around so that it can shield the operator from the light from either lamp.

While the lamp on the right is being exhausted, the lamp on the left is being removed from the clip which suspends it by the leading-in wires, another lamp is then thrust into the rubber tubing and connected to the clip. By this time the lamp on the right is sufficiently exhausted and current is passed through it by means of a rheostat on the left of the operator, and the process of exhausting is completed as indicated earlier in this article. After the exhausting is completed

the tube through which the air is exhausted is sealed off by the blow pipe flame which much resembles the jeweler's blow pipe flame, familiar to every student.

Bits of glass, dust, moisture from the air, phosphorous, etc., collect in the pipes and interfere at times with the action of the pinch cock valve. It is necessary to watch very closely to see that the lamps are being exhausted under the desired conditions.

Each type of lamp behaves a little differently from another type.

The tubular lamp is difficult to exhaust because the phosphorous gases are heavy, the residual gases in the lamp are light; the phosphorous is in the form of gas at a high temperature only, and the lamps cool quickly from the high temperature of the heater in which it was heated before being placed upon the pump.

The space in this lamp is narrow and long and as the glass of the lamp is always somewhat cooler than the phosphorous vapors, this added to the other difficulties mentioned makes it necessary that the tubular lamps be handled by our most skilled operators.

Lamps with small bulbs are difficult to exhaust for the last-named reason and also because they are so small that it is difficult to avoid vaporizing too much phosphorous. If too much phosphorous is vaporized the bulb of the lamp is discolored. Each size of lamp and each shape of bulb behaves a little differently from any other size or shape of bulb. The two examples are given above as illustrations only.

As the tube, through which the lamp is exhausted, which also carries the phosphorous must necessarily be of a resonable thickness, in order not to collapse when the blow pipe flame is applied to vaporize the phosphorous, it also must possess considerable heat capacity. As often only a very small amount of phosphorous vapor is required for the reaction there is every opportunity for an unskilled operator to use too much phosphorous, thereby making a lamp unsalable. An operator on a small lamp, or on a tubular lamp, or on a lamp in which the reaction is progressing freely, must be especially careful to withdraw the flame from the phosphorous-carrying tube long before the reaction is completed, as the phosphorous will continue to vaporize until the tube has cooled considerably. If an operator is sufficiently skilled, she can tell by watching the progress of the reaction in the lamp bulb as indicated by the changing color and form of the blue light which fills the bulb, when the reaction is about to be completed. A skilled operator will exhaust lamps with almost no rejections from one day to another. Such an operator is always very fast and always produces lamps of high quality. The contrary is true of one who is not skilled.

One reason that an operator who can always quickly vaporize just enough phosphorous and who does not vaporize too much phosphorous produces high-quality lamps is that the voltage at which it is necessary to operate these lamps in order to produce the temperature and the cross currents is such that if a lamp were burned at this temperature for many seconds the lamps would have passed much of its useful life. It is obvious that every second that can be saved when the lamp is being burned at this temperature adds hours to the life which the prospective customer will obtain from this lamp. This assurance that all the lamps exhausted by an expert operator will give practically the same life and candle-hours, other conditions being equal, is of great value.

Under the mercury pump régime the lamps burned not less than twenty minutes each at a voltage not less than 10 per cent. above normal. During only the last few minutes would the vacuum approximate that at which the lamps would ultimately burn. The lamps on the mercury pumps were also burned in addition to this at a voltage at least as high as that ever reached by the chemical methods and for a longer time.

Burning lamps at high incandescence before the vacuum becomes sufficiently good discolors the filaments. This raises the voltage at which the lamps deliver the candle-power for which they are designed, providing a good vacuum is ultimately produced in these lamps. When such lamps are shipped to the customer they are labeled to be operated at higher voltages than would have been the case had the lamps been exhausted by the modern process. In the days of the mercury pumps one of the principal causes for rejection of the lamps from some of the pump room operators was the blackened filaments resulting from this cause. In rejecting lamps for this cause, lamps with filaments only slightly burned were necessarily passed for shipment.

Such lamps would rise rapidly in candles at the beginning of their life and fall almost as rapidly after the first 50 or 100 hours. This condition has been almost entirely eliminated. Much of the improvement in lamp quality in recent years can be traced directly to better methods of exhaustion.

Lamps in which the gases have not been thoroughly eliminated from the joints between the filaments and the platinum wires will fall rapidly in candles when put into service. Much of the rapid decline in candles in the lamps exhausted on mercury pumps was due to the joints between the filament and the platinum discharging gases while in service.

The closer specifications to which modern lamps can be shipped can also be partly traced to this improvement in exhausting as indicated in the preceding paragraphs. When the history of the development of the incandescent lamp is written the most interesting chapters will be those which deal with this portion of the story. Only a very brief outline of the subject has been given above. Many hundreds of experiments and life tests and the expenditure of a great deal of money is summed up in this brief description.

Electric vs. Steam Locomotives.

Discussing the above topic, Mr. E. C. Boynton says, in a recent letter to the *Street Railway Journal:* "The writer, who has some knowledge of both sides of the question—that of the contest for supremacy between the steam and electric locomotive—is of the opinion that the fight has only begun. Certainly most steam engineers are to-day as confident of victory as ever, and do not consider the contest at all one-sided, as our electrical friends seem to think it. The strongest argument of the steam engineers is their contention that they will never be beaten in the long-distance haul. They do not necessarily mean high speed or great mileage per locomotive day, but length of track. They believe that there is a limit to the distance which it would pay to equip with electric traction a railway doing a general freight and passenger business, and in the present state of the electrical art they are right. They are not yet ready to admit defeat even in short-haul suburban passenger traffic, and will await the result of those, to them, experiments which are about to be tried at enormous expense by several railways.

"To one who has watched the improvements in both kinds of locomotives during the past five or six years, it is difficult to decide whether the steam or electric locomotive has improved the faster. The steam locomotive of to-day presents about the same comparison to that of the earlier date as does the modern interurban car to that of six years ago. The improvements in the steam locomotive, as exemplified in the 'Atlantic' and 'Lake Shore' types have been many. They include the wide fire-box, with its immense grate surface, and the increase in size and capacity of the boiler. The boiler pressure has been carried up to 250 pounds per square inch, and the steaming capacity of the boiler, even with poor fuel, has been made sufficient to supply the largest cylinders which could be used with the tractive weight of the engine. The use of the piston valve and the various types of compound cylinders has added greatly to the general efficiency.

"It must not be supposed that this increase in efficiency means higher speed with a decrease in consumption of fuel, water and oil. The steam engineer was not trying to do that, but to reduce the cost per ton-mile hauled, and he has succeeded. He hauls freight and passenger trains of far greater weight than before, and at higher speed at less cost.

"A somewhat mistaken idea has been held by many that the steam locomotive designer is trying to save weight. This is not always so, but frequently railways ordering new power specify the maximum weight, generally on account of the strength of their bridges, and sometimes the weight of their rails."

Government Telephony in France.

A cable dispatch from Paris says: "Drastic proceedings in the telephone administration of Paris, shown in the case of Mlle. Sylviac and others, are exciting a storm of protest in all directions. Among others a meeting has been held at the Palais de Justice at which 200 young lawyers were present. Four speeches were made against the assumption by the government of power to fine subscribers at will, and by 180 votes against 20 the telephone administration was scathingly censured."

Measurement of the Insulation Resistance of an Electric Wiring System.

BY EDWIN F. NORTHRUP.

THE writer recently had occasion to measure the insulation between each bus-bar and the gas pipes of the wiring system of a large city office building at a time and under circumstances where it was not practicable to shut off the power.

The measurement was made by two methods. As these methods are both generally applicable for determining the insulation resistance of each side of any wiring system while the power is on, we have deemed them to be of sufficient value to warrant description.

I.—VOLTMETER METHOD.

Let *A* (Fig. 1) represent any wiring system in which X_1 and X_2 are the insulation resistances between the bus-bars, B_1 and B_2 and

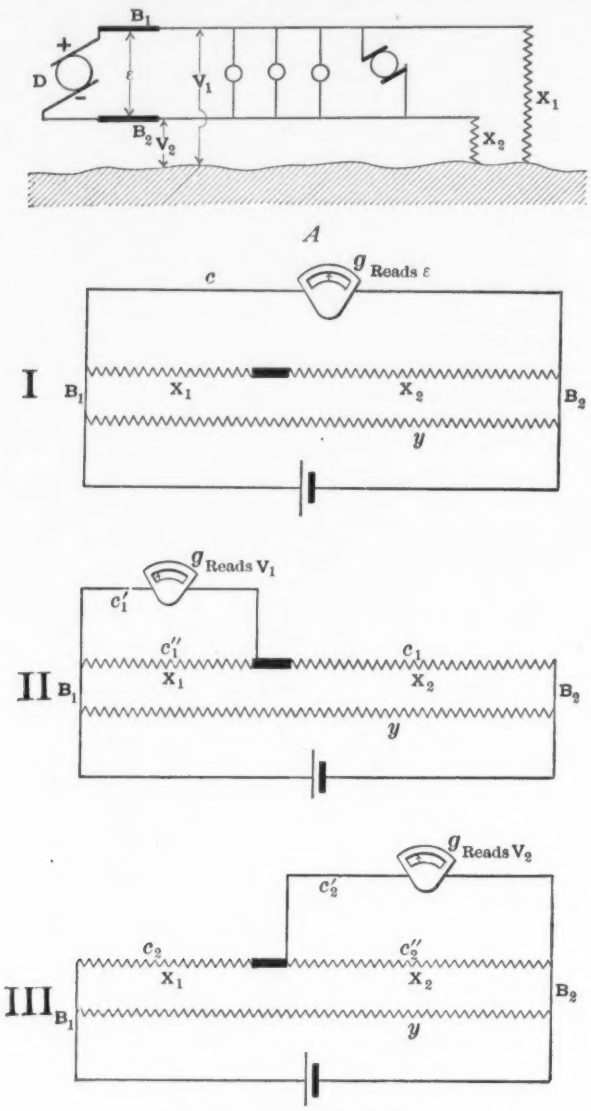


FIG. I.—VOLTMETER METHOD.

the earth (the gas or water pipes being taken as at the potential of the earth). In Fig. 1, *I, II* and *III* are equivalent diagrams in which *y* represents the unknown resistance of all the lamps, motors, etc., across the line.

If direct current is supplied to the bus-bars, a Weston direct-current voltmeter should be used. If the current is alternating, then an alternating-current Weston voltmeter will be required. The resistances, X_1 and X_2, are determined by knowing g, the resistance of the voltmeter, and by taking three voltmeter readings.

1st. Measure the voltage, which we will call E, across the bus-bars (Fig. 1) *I*.

2nd. Connect the voltmeter between the bus-bar, B_1, and the earth, and take its reading, which we will call V_1 (Fig. 1) *II*.

3d. Connect the voltmeter between the bus-bar, B_2, and the earth and take its reading, which we will call V_2 (Fig. 1) *III*.

If the readings in either of the two latter cases are only a fraction of a scale division, then the insulation resistance is too high to be measured by this method and we may resort to the second method to be described. Having taken the above three readings, it can be shown that

$$X_1 = \frac{g\ (E - V_1 - V_2)}{V_2} \qquad (1)$$

$$X_2 = \frac{g\ (E - V_1 - V_2)}{V_1} \qquad (2)$$

The current, I, which leaks to the ground will be:

$$I = \frac{E}{X_1 + X_2}$$

In the particular case above referred to, in which the insulation resistance of the wiring system of a large office building was determined by means of a Weston voltmeter, the following readings and resistances were obtained:

g = 12,220 ohms,
E = 113 volts,
V_1 = 1 volt,
V_2 = 4 volts.

$$X_1 = \frac{12{,}220\ (113 - 1 - 4)}{4} = 329{,}940 \text{ ohms},$$

$$X_2 = \frac{12{,}220\ (113 - 1 - 4)}{1} = 1{,}319{,}760 \text{ ohms}.$$

The above example shows that where the sum of the resistances, X_1 and X_2, are not over one or two million ohms, the voltmeter method is sufficiently accurate for the purpose. If one side of the line is grounded—that is, if $X_2 = 0$—then from (2) $E = V_1 + V_2 = V_1$, as $V_2 = 0$, and the method fails to give X_1.

Expressions (1) and (2) above are obtained as follows: The meaning of the letters used are indicated in *I, II* and *III* (Fig. 1), C_1, C_2, etc., being currents and g the resistance of the voltmeter.

$$C_1 = \frac{E}{X_2 + \dfrac{g\,X_1}{X_1 + g}},$$

$$C_2 = \frac{E}{X_1 + \dfrac{g\,X_2}{X_2 + g}},$$

$$C_1{}^1 = \frac{X_1}{g + X_1}\,C_1 = \frac{V_1}{g}, \text{ or } C_1 = \frac{V_1\ (g + X_1)}{X_1\,g},$$

$$C_2{}^1 = \frac{X_2}{g + X_2}\,C_2 = \frac{V_2}{g}, \text{ or } C_2 = \frac{V_2\ (g + X_2)}{X_2\,g}.$$

Hence, we have the two relations,

$$\frac{E}{X_2 + \dfrac{g\,X_1}{X_1 + g}} = \frac{V_1(g + X_1)}{X_1\,g}, \text{ and } \frac{E}{X_1 + \dfrac{g\,X_2}{X_2 + g}} = \frac{V_2(g + X_2)}{X_2\,g},$$

from which the values for X_1 and X_2 are obtained as given above in equations (1) and (2).

Any instrument, as a galvanometer, in which the deflections are proportional to the currents may be substituted for a voltmeter. In such a case, if D, d_1 and d_2 are deflections corresponding to the readings E, V_1 and V_2, and G is the total resistance in series with the instrument, we have as before:

$$X_1 = \frac{G\ (D - d_1 - d_2)}{d_2} \qquad (3)$$

and

$$X_2 = \frac{G\ (D - d_1 - d_2)}{d_1} \qquad (4)$$

If two or more electric lamps are connected in series, their resistances, while carrying current, can be determined by means of three readings, as above.

If $X_2 = \infty$, $V_1 = 0$, and $X_1 = \dfrac{g\ (E - V_2)}{V_2}$, which is the ordinary expression used in measuring a resistance with a voltmeter by reading the voltmeter with the resistance in series with it and again with the resistance cut out.

II.—GALVANOMETER METHOD.

This method may be used when greater accuracy is required or when the insulation resistance to earth, of at least one side of the line, is over a megohm.

The wiring system is represented in 1 of Fig. 2, and 2 of Fig. 2 gives equivalent circuits.

The method consists in connecting across the bus-bars a moderately high resistance and finding on this resistance a point, p, where the potential due to the generator is the same as that of the earth, and then with the aid of a sensitive galvanometer and an external source of e.m.f., measuring the resistances, r_1 and r_2, to earth in the following manner: k is a key and S an Ayrton universal shunt. This latter may be omitted if the source of e.m.f. can be varied in a known manner.

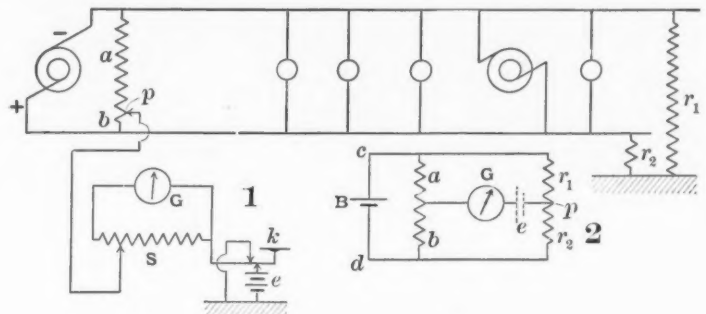


FIG. 2.—GALVANOMETER METHOD.

It is evident from Fig. 2 that a balance will be had when $\dfrac{a}{b} = \dfrac{r_1}{r_2}$, the key, k, being in its upper position. If k is now depressed, the resistance, R, encountered by the current generated by the source, e, will be

$$R = g_1 + \frac{1}{\dfrac{1}{b + r_2} + \dfrac{1}{a + r_1}}$$

where g_1 is the resistance of the galvanometer; but in comparison with r_1 and r_2, g_1, a and b can be neglected, and

$$R = \frac{r_1\ r_2}{r_1 + r_2}.$$

By construction, $\dfrac{r_1}{r_2} = \dfrac{a}{b} = N$, a known ratio. From the last two relations we deduce

$$r_2 = \frac{R\ (N + 1)}{N}$$

and

$$r_1 = R\ (N + 1)$$

Taking d as the deflection of the galvanometer and K as the galvanometer constant, the current through the galvanometer is $\dfrac{e}{R} = \dfrac{d}{K}$, or $R = \dfrac{e\,K}{d}$.

K should be defined as the resistance which must be inserted in circuit with the galvanometer (including its own resistance), so that it will give, with one volt, a scale deflection of one scale division at the distance at which the scale is placed from the mirror during the test, usually taken as one meter.

Then we will have:

$$r_2 = \frac{e\,K\ (N + 1)}{N\,d}$$

and

$$r_1 = \frac{e\,K\ (N + 1)}{d}.$$

Taking $K = 10^8$ as an average value for an ordinary D'Arsonval galvanometer and $e = 100$, $n = 2$, and $d = 100$, we have:

$$r_2 = \frac{100 \times 10^8\ (2 + 1)}{2 \times 100} = 150 \text{ megohms},$$

$$r_1 = \frac{100 \times 10^8\ (2 + 1)}{100} = 300 \text{ megohms}.$$

This example shows that a galvanometer of very moderate sensibility will measure in this way a very high insulation resistance. If, on the other hand, the insulation is low, small battery power may be used or the deflection of the galvanometer can be cut down to 1/10, 1/100, 1/1000 or 1/10000 by the Ayrton shunt. The only difficulty likely to be experienced in applying the above method is that, while making the test, the relative values of r_1 and r_2 will keep changing, due to motors or lights being thrown on or off the line. In this event it is only possible to obtain a sort of average value for the resistance to earth of each side of the line.

Evidence by Telephone.

The following is a suggestive comment by the New York *Times* on the receiving of evidence by telephone: "A notable incident of an otherwise uninteresting murder trial now going on in this city followed an attempt by the prosecuting attorney to utilize a means of communication that is considered, outside of court rooms, perfectly satisfactory for almost every purpose, including many of the greatest importance. The prisoner had testified that he had owned the revolver with which he did the killing—in self-defense, he asserted—since 1901, while the prosecution, having noted the number on the weapon, had learned from its manufacturers that it was made in 1903. This information, with its obvious bearing on the prisoner's credibility, and, in a slighter degree, on the question of premeditation, had been obtained by long-distance telephone during a recess of the court, and the prosecutor naturally wanted to get it before the jurymen. He therefore proposed the immediate installation of a telephone in the court room, in order that the jury might hear a repetition of his inquiries about the pistol and the manufacturers' replies. This plan was in complete accord with the habitual conduct of business affairs at the present time, and its convenience and economy would have recommended it to any layman desirous merely of ascertaining a needed fact, quickly and correctly. Telephones, however, were invented some years since the rules of procedure in murder trials were established, and no sooner had the suggestion been made than the prisoner's counsel leaped to his feet with a vehement objection, based on the fine old principle that it is a defendant's constitutional right to be confronted by the witnesses against him. Of course the judge held that the objection was well taken and the telephone plan had to be abandoned. The question of the pistol's age was of no particular consequence, and perhaps the prosecutor made his point with the jury about as well as if he had been allowed to do what he desired, but the episode illustrates again the curious inharmony between court methods and principles of action and those accepted and followed in the ordinary relations of life."

The Protection of Telephone or Telegraph Lines When in Hazardous Proximity to High Tension Lines.

BY ROBERT E. CHETWOOD, JR.

THERE appeared recently in this paper an article by Howard S. Knowlton entitled "The Prevention of Crosses Between Signalling and High-Voltage Circuits," the principal features of which were descriptions and illustrations of what are commonly termed "short span" crossings. The descriptions and illustrations given by Mr. Knowlton were those originally contained in specifications, now obsolete, which were prepared by one of the leading Bell telephone companies at the time when it first became necessary to make provision for the crossing of high-tension and telephone lines. Since these specifications, which form the basis of Mr. Knowlton's article, were issued, the increase in the number of both telephone and high-voltage lines has been so rapid that the entire subject of the protection of telephone circuits when in proximity to high-voltage wires has been carefully studied and various types of protected crossings designed. It is the purpose of this article to describe several types of protected crossings in the design of which the writer has been identified.

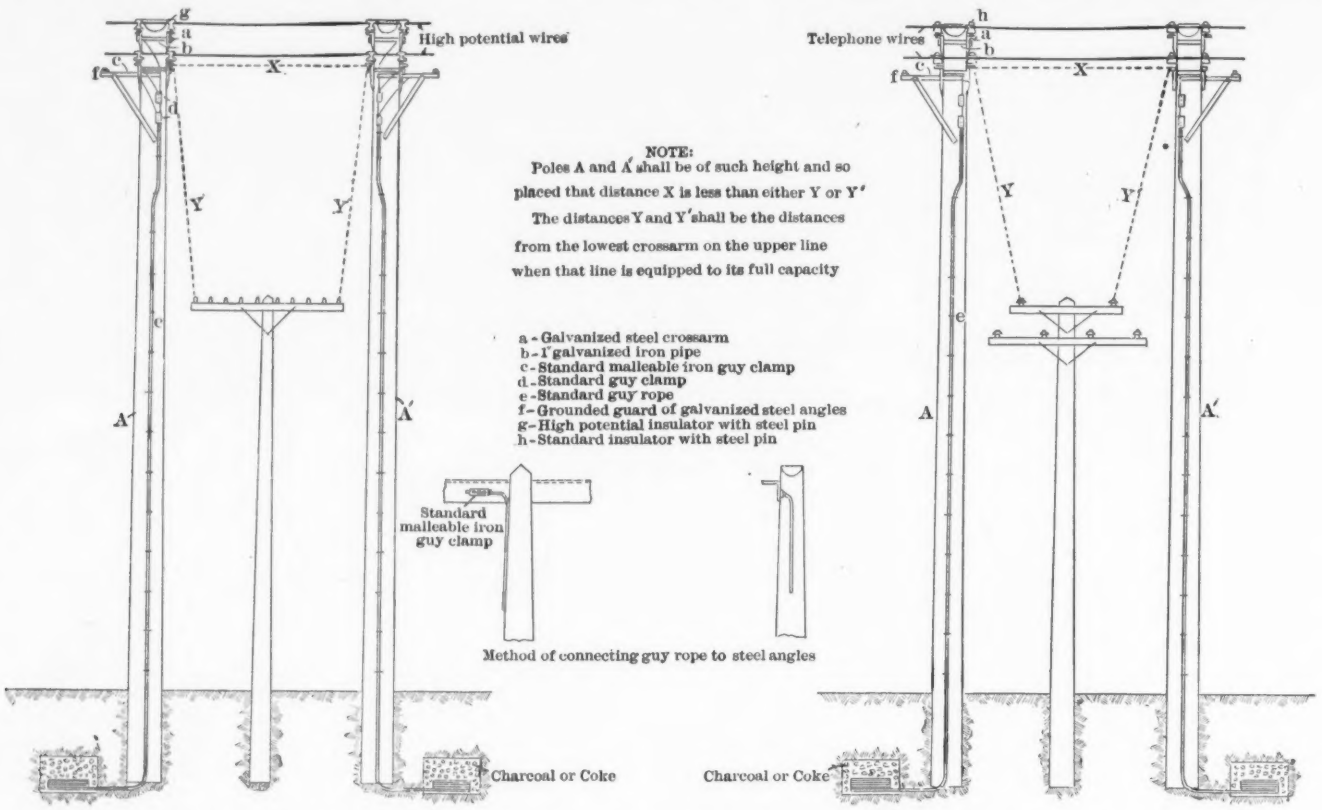
In Figs. 1 and 2 are shown the construction of short span crossings, Fig. 1 illustrating a short span in the high-tension line and Fig. 2 showing a short span in the telephone line. It will be readily seen that the construction illustrated, while embodying the fundamental feature, differs radically in the details from those described in the article referred to. The short span crossings described by Mr. Knowlton failed to provide any protection against one of the greatest and most frequent sources of danger, namely, the puncturing of the insulators on the high-tension line, resulting generally in the burning through of the wooden cross arm, thus allowing the high-tension wire to come into contact with the wires of the telephone line crossing below.

In the construction illustrated in Fig. 1, the cross arms and pins are of galvanized steel angles and are grounded by means of a galvanized-wire rope of ample current-carrying capacity for the line in question. Besides the use of grounded steel pins and cross arms the poles forming the short span are fitted with an extension guard of galvanized steel angles. This guard projects out from the pole about eighteen inches and is two feet longer than any cross arm, the object being that in the event of a wire breaking in an adjacent span it will be in contact with this grounded guard before and at the time it may swing into contact with the wires of the line below.

Other details in which it differs from the construction recommended by Mr. Knowlton is that it requires the poles of the short span to be double-armed and the line wires securely tied to the insulators on the arms. The dead-ending of heavy high-tension wires and completing the circuit by means of a loop is not considered good practice, inasmuch as the power wires are likely to be injured in dead-ending. The construction also requires the outside wires on the cross arms of the short span to be tied to the inside or pole side of the insulators, in order that in the event of tie wires breaking or unrolling, the line wires will be held on the grounded cross arms by means of the steel pins.

The method of grounding the wire ropes, as shown in the figure, is to make their ends up into coils of at least six turns and not less than eighteen inches in diameter and to bury them at or near the base of the poles. The holes in which the coils are placed should be not less than six feet deep and should be dug until moist earth is reached. Over the coils is dumped three bushels of fine charcoal or coke. In some instances it will be necessary to carry the wire ropes some distance from the base of the poles in order to obtain a good ground connection.

The short span type of crossing for high-voltage and telephone lines is undoubtedly the most desirable one and the short span


High potential wires
Telephone wires
NOTE:
Poles A and A' shall be of such height and so placed that distance X is less than either Y or Y'
The distances Y and Y' shall be the distances from the lowest crossarm on the upper line when that line is equipped to its full capacity
a - Galvanized steel crossarm
b - 1" galvanized iron pipe
c - Standard malleable iron guy clamp
d - Standard guy clamp
e - Standard guy rope
f - Grounded guard of galvanized steel angles
g - High potential insulator with steel pin
h - Standard insulator with steel pin
Standard malleable iron guy clamp
Method of connecting guy rope to steel angles
Charcoal or Coke
Charcoal or Coke

FIGS. 1 AND 2.—CONSTRUCTION OF SHORT SPANS AT CROSSINGS WITH HIGH-POTENTIAL LINES.

should, if possible, be constructed in the high-tension line. To assist in obtaining a short span crossing with the short span in the high-voltage line, the spacing of the pins on the telephone cross arms can be reduced so that a six-foot cross arm may be used instead of the standard ten-foot arm. This, of course, will allow of a shorter span, and, therefore, shorter poles in the power line.

A crossing constructed as above is as near safe as it is possible to conceive. If it is found impossible to make the crossing with the power line overhead, by using the same precautions, the telephone or telegraph line can be the overhead line.

While the short span method of crossing is the ideal method it so happens that in the majority of cases the crossing comes at the intersection of streets or roads where the conditions would require the use of poles of such a height and such guying rights as to render the method obviously impossible. The best method of crossing under these conditions is to have the high-tension line cross over the telephone or telegraph line and to protect the lower line, as shown in Fig. 3.

This protection consists in stringing between the poles of the telephone line, as close to their tops as is possible, a grounded steel rope of such size that it will safely carry at least three times the

normal current in the power wires, and below this grounded rope of placing an insulated screen of 12 No. 6 B. W. G. galvanized-iron wires. The telephone line wires are then carried as usual on cross arms located below the arms carrying the screen of No. 6 wires.

The action of such protection is as follows: The grounded rope, being of such size that it will safely carry three times the normal current in the power wires, will generally be between one and one-

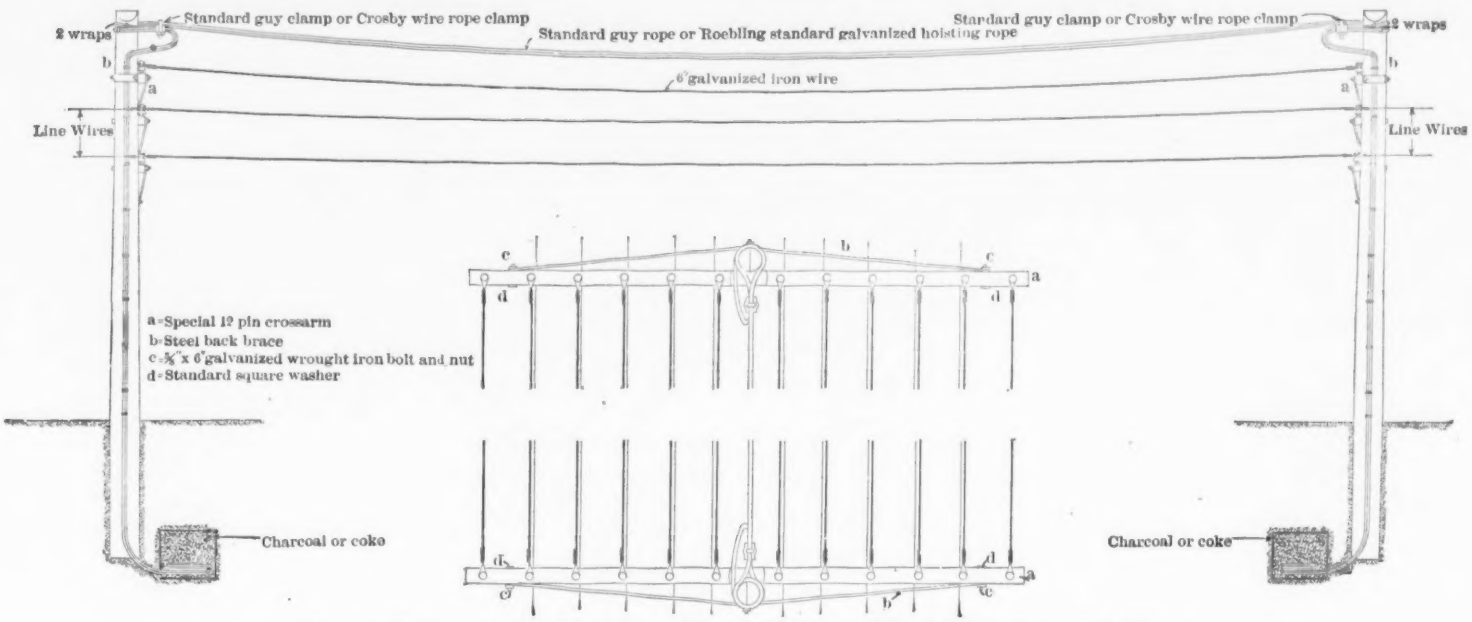

Standard guy clamp or Crosby wire rope clamp
2 wraps
Standard guy rope or Roebling standard galvanized hoisting rope
6 galvanized iron wire
Line Wires
a = Special 12 pin crossarm
b = Steel back brace
c = ⅝" x 6' galvanized wrought iron bolt and nut
d = Standard square washer
Charcoal or coke

FIG. 3.—PROTECTION FOR TELEPHONE WIRES CROSSING UNDER HIGH-POTENTIAL WIRES.

half and two times the diameter of the power wire; in fact a good rule to follow is to select a size of rope that is one and a half times the diameter of the power wire. In case a power wire breaks or sags, this grounded rope will be directly in its path and the contact

power wire whenever an arc is formed between this wire and the grounded rope. It is believed that it is the heat generated by the arc rather than the amount of current that flows that will cause fusing. That being the case, the grounded rope, being of iron or steel, having a higher fusing temperature than copper or aluminum and having a greater radiating surface, will probably fuse the high-tension wire, allowing it to fall harmlessly to the ground. The insulated screen of 12 No. 6 B. W. G. galvanized wires, which extends a foot on each side beyond the telephone wires, serves as an additional protection to the telephone or telegraph wires while the power wire is in contact with the galvanized rope or after it has been fused by this rope.

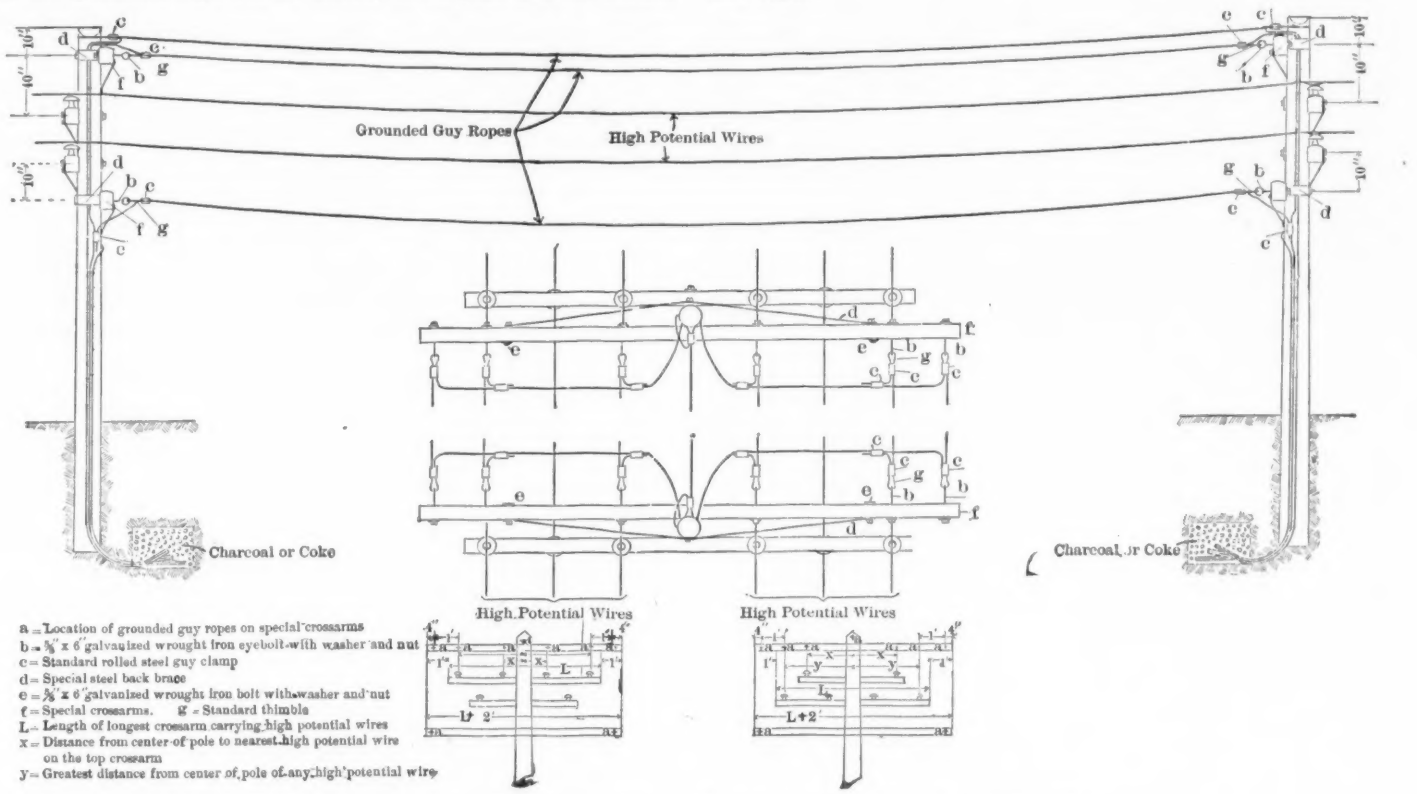

Grounded Guy Ropes
High Potential Wires
Charcoal or Coke
Charcoal or Coke
High Potential Wires
High Potential Wires
a = Location of grounded guy ropes on special crossarms
b = ⅝" x 6" galvanized wrought iron eyebolt with washer and nut
c = Standard rolled steel guy clamp
d = Special steel back brace
e = ⅝" x 6" galvanized wrought iron bolt with washer and nut
f = Special crossarms. g = Standard thimble
L = Length of longest crossarm carrying high potential wires
x = Distance from center of pole to nearest high potential wire on the top crossarm
y = Greatest distance from center of pole of any high potential wire

FIG. 4.—PROTECTION FOR TELEPHONE WIRES CROSSING OVER HIGH-POTENTIAL WIRES.

between the two, depending of course upon the type of the transmission system involved, will or will not operate the safety devices at the power station. It will in any event probably lower the voltage on the power wires and render it incapable of doing any damage to the telephone wires.

It is also extremely probable that the grounded rope will fuse the

Of course the efficiency of the grounded rope depends greatly on the ground connection secured, and this part of the construction should be given great attention. In general a good ground can be obtained as previously described, but in some cases extraordinary measures must be taken to make sure of a permanent and perfect ground connection.

When, due to excessive cost or to local conditions, it is impossible to make a short span crossing, and, furthermore, it is necessary for the telephone or telegraph line to cross above the high-voltage line, the crossing should be protected as shown in Fig. 4, where the protection is placed on the high-potential line, or as shown in Figs. 5 and 6, where the protection is placed on the telephone line.

of the construction are sufficiently well illustrated by the figure to need no further comment.

In Figs. 5 and 6 are given two views of the type of protection that should be used when it must be located on the telephone or telegraph line. It consists of a grounded net situated directly below the telephone wires and with which a telephone wire must be in

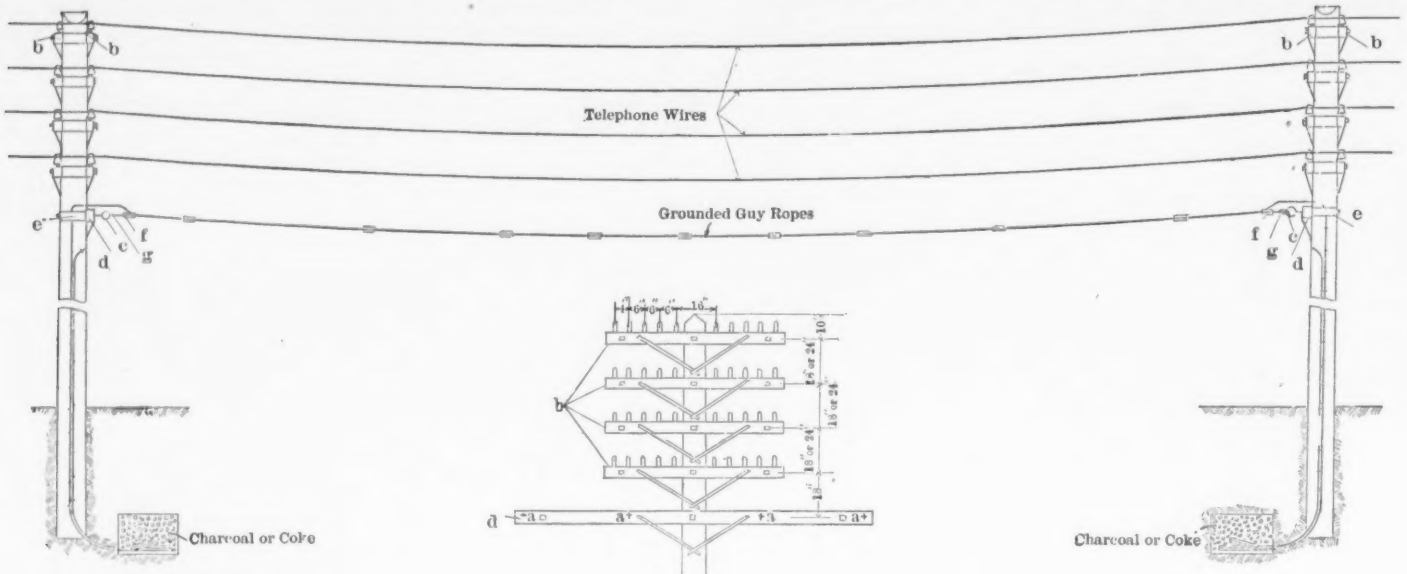

Telephone Wires
Grounded Guy Ropes
Charcoal or Coke
Charcoal or Coke
a = Location of grounded guy ropes
b = Standard six pin crossarm bored for ten pins
c = ⅝" x 6" galvanized wrought iron eyebolt with washer and nut
d = Special 12' crossarm
e = Steel back brace
f = Standard rolled steel guy clamp
g = Standard thimble

FIG. 5.—SIDE VIEW OF PROTECTION FOR TELEPHONE WIRES CROSSING OVER HIGH-POTENTIAL WIRES.

The protection shown in Fig. 4 consists of placing on the power line grounded wire ropes, so situated that a telephone or telegraph wire in falling will be in contact with a grounded rope before and at the time of contact with a high-potential wire. Under such conditions it seems probable that the telephone wire will then be unable

contact before and at the time it comes in contact with a high-potential wire on a line crossing under the telephone line at right angles. The construction involved is readily understood from the figures.

At all protected crossings, no matter what the type of protection

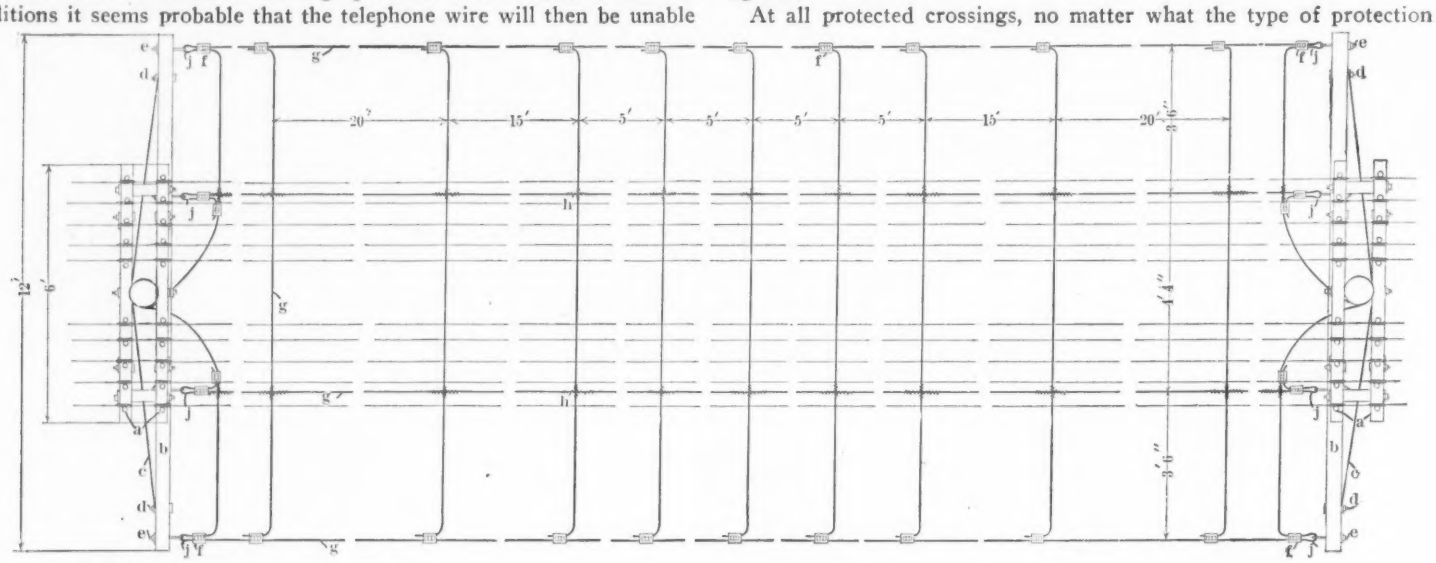

20'
15'
5'
5'
5'
5'
15'
20'
12'
6'
a = Standard six pin crossarm bored for ten pins
b = Special twelve foot crossarm
c = Steel back brace
d = ⅝" x 6" galvanized wrought iron bolt with washer and nut
e = " " " " " Eyebolt " " " "
f = Standard rolled steel guy clamp
g = Standard guy rope
h = 6 galvanized iron wire
j = Standard thimble

FIG. 6.—TOP VIEW OF PROTECTION FOR TELEPHONE WIRES CROSSING OVER HIGH-POTENTIAL WIRES.

to transmit any voltage of a dangerous value past the point of contact with the grounded rope. This grounded rope must, of course, be of such size as will insure the fusing of the telephone or telegraph wire and which will also carry without fusing several times the normal current carried by the power wire.

The location of the grounded ropes should be determined as shown in Fig. 4, and the construction should be mechanically strong. It is obvious that the power line must be dead at the time such protection is installed, a condition that is sometimes hard to meet. The details

may be, the poles of both lines should be specially selected in regard to strength and should be so guyer as will make their breaking or falling well nigh impossible. The guys attached to the poles of both lines should be grounded and the insertion of suitable strain insulators in the guys attached to the telephone line at or near the telephone poles is recommended as an additional measure of safety. In no case should the guys of one line be attached to the poles of the other line.

The above methods of protecting telephone or telegraph lines at points where they come into hazardous proximity to high-tension lines are those in use by one of the largest Bell Telephone companies. They are the result of considerable study and have been constructed at a number of crossings. While the expense of the construction, especially in making short span crossings, has been considerable, the measure of safety that has been procured not only to their own property but to that of their patrons overbalances any consideration of expense.

Electrical Illumination of the Louisiana Purchase Exposition.

BY CLOYD MARSHALL.

THE spectacular effects which make one exposition more notable than its predecessor, are due largely to electric lighting. Electrical engineers have learned much about illuminating effects from expositions, for nowhere else are presented the problems of brilliantly lighting such great areas, both indoors and out. After much discussion and experiment it has been decided that the most satisfactory result of illuminating the grounds and architecture, can be secured by the use of incandescent lamps alone. By spacing the lamps at short intervals, the effect is a line of light marking each architectural outline. Within the buildings the result derived is wholly different, for the light must be such that the visitors can examine minute details, and read inscriptions anywhere. Arc lights of high candle-power, with suitable reflectors, give, in general, the best results.

The lighting at the Louisiana Purchase Exposition has been carried out on this general plan. The area of the Exposition grounds is about two square miles, of which the buildings cover approximately 130 acres, and it has been a herculean task to properly light so great an area.

The main picture of the Exposition, embracing the Grand Basin, the Plaza of St. Louis, Festival Hall, the Colonnade of States, the Electricity, Education, Manufacturers' and Varied Industries Buildings, has been lavishly festooned with electric lights. Festival Hall, with its dome rising 325 ft. above the Plaza, is marked in every outline with incandescent lamps. There are two flanking colonnades extending in an arc a quarter of a mile in length, terminating in a pavilion at either end. Each light unit on the colonnade consists of three incandescent lamps, white, amethyst and emerald, which, by means of the regulating devices, give beautiful color effects. About 20,000 lamps are used to make this a crowning feature. All cornice lines, columns, the vertical lines of the corners and main entrances, and all architectural decorations of the surrounding buildings, are marked with incandescent lamps, spaced 15 in. centers. Around the Grand Basin and lagoons are railings supported by ornamental lamp posts, as shown in the illustration. Sixty 8-cp incandescent lamps are carried on each post, and Meridian lamps are supported by the four arms.

All the central buildings have colonnades, which are even more beautiful by night than in the day time. At the rear of each column is a vertical line of lamp. The light striking the building walls behind brings the columns in sharp outline against a bright background. The outlines of the other buildings are more subdued than the brilliant spectacle around the Grand Basin, yet at night the whole Exposition appears as a city of light; and this will doubtless appeal to the imagination of the greatest number of visitors.

Power sufficient for this purpose had to be secured from three sources, an exhibitors' power plant, consisting of about fifteen direct-connected units ranging from 400 to 5,000 hp each; the Westinghouse service plant of four 2,800-hp units, and 7,500 kw to be rented from the Union Light & Power Company, of St. Louis. Of this 10,000 hp is to be used for lighting alone.

From the switchboard in the west end of the Machinery Hall mains extend through the conduits to the various sub-stations about the grounds. These conduits consist of pump log ducts which were familiar to the engineer in years gone by, but to-day are almost a curiosity. However, for a year's service these will answer the purpose very well and will likely never be removed from the trenches. The trenches are lined with boards and the ducts having a square cross-section can be placed in number suitable to accommodate the circuits. Under the lagoons the ducts are laid in cement. Manholes of timber construction are placed at convenient intervals along the principal thoroughfares. For power and lighting lead-covered cables are used, and these will be removed for further service after the Exposition. All telephone, telegraph and other wires about the grounds are carried in these same ducts, and no wires of any description are overhead.

The power supply is a 6,600-volt, three-phase current, direct from the large generators to the step-down transformers in the sub-stations. The one in Electricity Building is a typical installation. The mains reach the switchboard through the conduits and to the primaries of the twelve transformers. Three are General Electric oil-cooled, 100-kw, three-phase transformers, giving a secondary voltage of 110 volts for power within the building. The three larger General Electric 250-kw transformers with a secondary of 110 volts furnish power for decorative lighting on the outside of the building. The 200-kw Westinghouse rotary converter is supplied from three 75-kw transformers at 388 volts, and delivers 550 volts direct current for power to operate exhibits. Two motor-generators of 100 kw each supply an Edison three-wire system throughout the building. Insulated cables are carried up from the sub-station switchboard, and extend entirely around the building, supported by porcelain insulators on the trusses. Different circuits are tapped in as the exhibitors may need for power or light, and the wires are supported on cleats attached to the girders. These run to a post in the exhibitors' space and down to a switchboard.

For decorative lighting the cables run to the roof of the building. On the balustrade above the cornice line are switchboards, and from these the lighting feeders extend around the entire circumference of the building. The small circuits are connected at convenient points and run to the columns, flag staffs, or along the cornice line. The wiring is concealed where its presence would detract from the appearance of the structure, and in such places rubber-covered wire only has been used, and is brought to the surface through porcelain tubes. In such cases the sockets are attached to the woodwork and

FIG. I.—COLUMN ALONGSIDE OF LAGOON.

embedded in the staff so as to appear a portion of the column or ornament. This work has been done since last summer and fall and to prevent deterioration during the winter the sockets were filled with a tar composition which was readily removed before the lamps were put in place. Along the cornice lines and other places too remote to notice the circuits are carried on porcelain cleats, and in such cases slow-burning weather-proof insulation was used.

The arc lights within the building are in series on a 3,500-volt, 50-cycle circuit. Except in the Electricity Building, the sub-stations are enclosed in brick structures to reduce the fire risk to a minimum. Although all this work is for temporary purposes only, it has been so well planned and executed that when the lights were turned on and the circuits tested, not one serious flaw was found.

One of the interesting and novel features of the interior lighting is the application of Nernst lamps on a large scale to the lighting of the fine arts exhibit. In arriving at the decision to adopt the Nernst lamp, the art gallery officials made careful tests to determine the practical value of its advantages in this field of lighting, namely, white quality, steadiness and economy. In addition, it was claimed that owing to the downward distribution of the light, a great uniformity of illumination would be secured over the wall space usually occupied by an art exhibit, the weaker rays being in the direction of the upper and the nearer portions of the wall, and the stronger rays

FIG. 2.—THE CASCADES—LAMPS UNDER PARAPET.

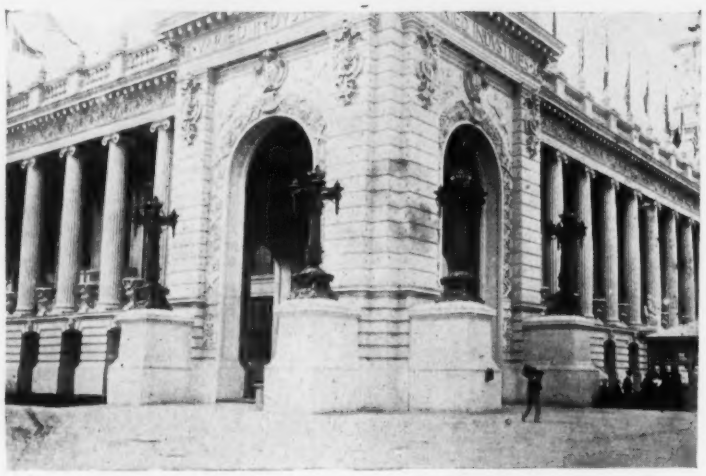


FIG. 3.—LAMPS ON THE INDUSTRY BUILDING.

FIG. 4.—ILLUMINATED COLUMN ALONG THE TERRACE OF STATES.

FIG. 5.—LOOKING FROM FESTIVAL HALL—LAMP STANDARDS.

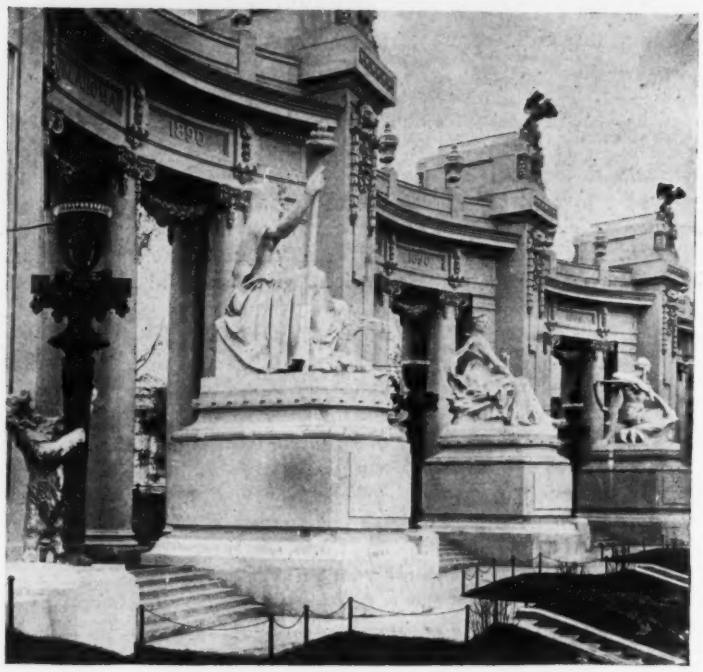


FIG. 6.—TERRACE OF STATES SECTION—LAMPS ON COLUMNS.

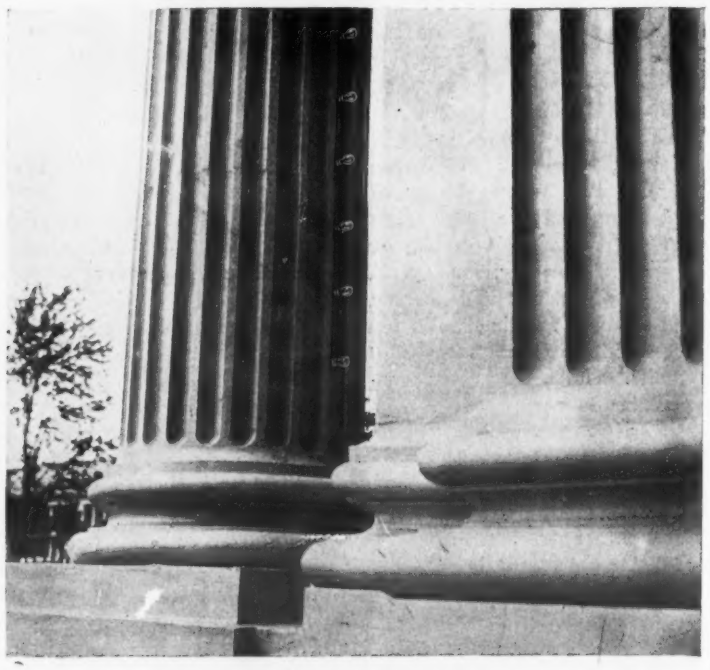


FIG. 7.—EDUCATIONAL BUILDING—LAMPS INSIDE ROW OF COLUMNS.

ELECTRICAL ILLUMINATION AT THE LOUISIANA PURCHASE EXPOSITION.

in the direction of the lower and more distant portions. Where the exhibits occupy the walls exclusively, the uniformity and intensity of the wall illumination is greatly improved by the use of a specially designed reflector on each lamp, similar to that shown in Figs. 1 and 2.

This reflector is of light, rigid construction and is fastened to

FIG. 8.—NERNST LAMP WITH REFLECTOR FOR ART GALLERY.

and supported by the lamp, in the same manner as the standard shade. Of course, this reflector also acts as a shield, preventing

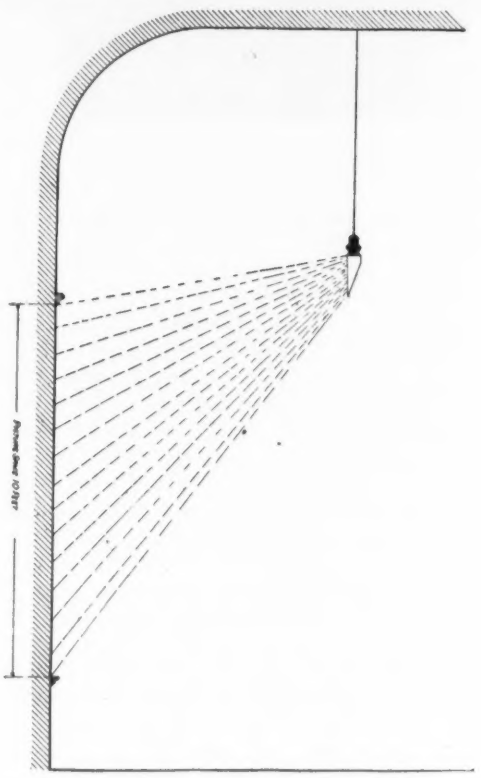


FIG. 9.—ARRANGEMENT OF LAMP AND REFLECTOR.

direct light from entering the eye of the observer. The preliminary tests which were made using this reflector and under conditions approximating as near as practicable the actual art gallery conditions, were attended with very satisfactory results.

The plans involve the use of 1,541 Nernst lamps of different sizes, making a total of 4,780 glower units, with a total consumption of

FIG. 10.—NERNST LAMP REFLECTOR FOR ART GALLERY.

401,520 watts. The sculpture halls will be lighted by means of large clusters, each consisting of 19 six-glower lamps at 60 ft. elevation. In the art gallery section the three-glower lamp, with the special reflector will be the standard unit, these being arranged around the four sides of the room 8 ft. from the wall, as shown in the cut. The lamps will all be supplied with 25-cycle current from a single-phase, 210-volt circuit, a portion of the load on the latter being used for power purposes.

New Hudson River Tunnels.

The New York State Board of Railroad Commissioners last week granted a certificate of public necessity to the Hudson & Manhattan Railroad Company to build two single-track tunnels under the Hudson River from Church Street, between Cortlandt and Fulton Streets, New York, to Exchange Place, Jersey City. It is stated that the company has bought the western part of two blocks bounded by Church, Fulton and Cortlandt Streets and Broadway. The Havemeyer Building occupies one of these plots.

The two tunnels will form a continuous loop. The south tunnel will come from the river under Pier 13 and Cortlandt Street to the loop station at Church Street, running around into the north tunnel under Fulton Street and Pier 14. From the terminus there will be a footway under Dey Street to Broadway and the subway station there and up to Broadway and John Street, the passageway being under the subway level. A very comprehensive system of connections with existing and developing lines of communication is contemplated by the plans.

The Magnetite Arc Lamp.

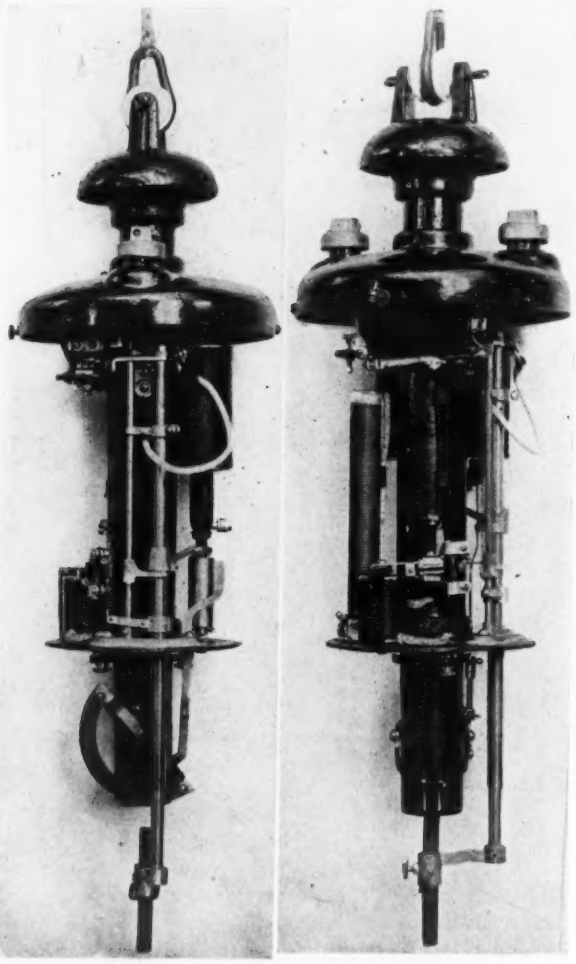
BY CHARLES PROTEUS STEINMETZ.

WHILE in the transformation of electric into mechanical power very high efficiencies are reached, values of 90 per cent. to 95 per cent. being quite common, the efficiencies of the present method of producing light from electric energy are extremely low, only about 2 per cent. in the incandescent lamp, perhaps 5 per cent. in the arc lamp. The reason hereof is to be found in the use of heat as an intermediary form of energy, which always leads to low efficiency. To study the methods of producing light from the point of view of developing more efficient methods, some years ago an electrochemical laboratory was established by the General Electric Company and one of the results of the work of this laboratory is represented in the magnetite arc lamp.

The most efficient illuminant heretofore known was the carbon arc, but its efficiency is due to the extremely high temperature, and, therefore, great brilliancy of the incandescent crater of the carbon; and very little light is produced by the arc flame and that of a rather undesirable violet color.

Improvements in efficiency have been made in the last years by adding metal salts as calcium-fluoride to the carbon, which evaporate in the arc, making it luminous and so increase the efficiency, but since all such substances produce a smoke or dust, which has to be disposed of, the carbon cannot be enclosed air-tight and the flame carbons, therefore, give a short burning arc requiring frequent trimming.

In these flame carbons, on which a considerable amount of work



FIGS. 1 AND 2.—3½-AMPERE LUMINOUS ARC LAMP.

was done, the arc-coloring substance is added to the positive terminal as the hottest, from which evaporation takes place more rapidly than from the negative. When used in this manner only calcium compounds seem to give a very good efficiency, and they are mostly used. Their light, however, is of a reddish yellow hue.

Even with its much greater efficiency, due to the short life and the yellow color, the flame carbon arcs do not seem to me to quite meet the requirements of an illuminant able to compete with the enclosed arc of to-day for general illumination, but as the first fundamental condition to be met by an illuminant which should be superior to the present arc lamp for general illumination, I consider besides very high efficiency, long life and white color of the light. While variously colored lights may find some application for decorative purposes, for general illumination, for replacing the daylight during the night, a white light is most desirable, even necessary wherever color values have to be judged.

The condition of long life, with an open arc, excludes the use of carbon in the electrodes and some other carrier of the current in the arc flame must be found. The material which in an arc lamp electrode, by replacing the carbon used at present, would constitute an essential advance in the art of illumination, must, therefore, fulfill the following conditions:

It must be a good conductor when solid and its vapors must be conductors of the arc.

It must be incombustible so as to give a long burning arc.

It must give a spectrum of high brilliancy; that is, an arc of high efficiency.

The light must be distributed approximately uniformly over the whole spectrum; that is, it must give a white light.

In magnetite, or the black oxide of iron, one of the most common iron ores, a substance was found having the required characteristics.

By very extensive investigations of the phenomena taking place in the electric arc with different materials as arc terminals, it was found that the material which carries the arc flame issues from the negative terminal as a high velocity blast which, when striking the

FIG. 3.—MAGNETITE ARC.

positive, produces heat. If, therefore, the positive terminal cannot conduct this heat away, it may get hotter than the negative and does so in the carbon arc.

Therefore, in the carbon arc the positive terminal burns away more rapidly. The greater heat produced at the positive terminal is the reason for introducing arc-coloring substances in the flame carbon arc lamps into the positive electrode. They are introduced into the arc by evaporation, and at the hotter positive electrode evaporation is more rapid. This also has led to the misconception that the positive terminal feeds the arc while in reality it has no direct influence on the phenomena in the arc, but the spectrum of the arc is that of the negative terminal, except where material of a boiling point lower than the temperature of the arc flame is introduced into the arc.

If the positive terminal is made large enough and a good conductor of heat so as to carry away the heat, it does not wear away, but material from the negative terminal deposits on the positive, as drops of magnetite on the copper positive of the magnetite arc lamp if the latter is too large. By giving the positive terminal, therefore, a sufficient heat conductivity not to get too hot, but sufficiently hot to avoid the deposition of material on it, a non-consuming positive electrode is produced. This is the case in the magnetite arc lamp. In this only the negative or lower electrode consists of magnetite, and is consumed. The positive terminal is not replaced, but is a copper segment, which constitutes a permanent part of the lamp.

The metals of the iron group yield a brilliant arc flame of very high efficiency and white color. To give a long life the metals which are combustible are not well suited, but a stable oxide of these

metals must be used; that is, a compound which cannot burn any more. Amongst the conducting oxides, magnetite fulfils best the requirements of a carrier of the arc flame, since it is well conducting, stable at all temperatures, very plentiful in nature, and gives a white arc of high efficiency.

Pure magnetite, however, is not quite satisfactory, since its efficiency is not very high, hardly twice as high as that of the ordinary carbon arc; and the arc tends to flicker and the rate of consumption of the electrode is rather high; as high as ⅛ in. per hour. This, while very much lower than the rate of consumption of flame carbons, of 1 in. to 2 in. per hour, would still give only 50 to 60 hours' life with the standard size of electrode adopted for the magnetite arc lamp, of 8 in. length. Therefore, with the magnetite as carrier of the arc flame are incorporated other substances in small quantities as arc-steadying compounds—titanium compounds for increasing the efficiency, etc.

In the manufacture of these magnetite arc electrodes, by partially reducing the material to metal, a greater density is produced and so a

FIG. 4.—MAGNETITE STREET LAMP.

greater amount of material with the same size of electrode, which gives a longer life. Such partial reduction, however, has the disadvantage that when not carried far enough it leaves the electrode porous and of relatively short life, while when carried too far, the light tends to unsteadiness, turns faint and blue whenever the arc strikes metal and in this case scintillating sparks are thrown off, which may crack the outer lamp globe. A much better method of producing electrodes was found by not reducing the material, but adding a restrainer; that is, a substance which added to the electrode material in small quantities reduces the rate of consumption. Hereby, without any loss of efficiency, rates of consumption of 20 to 30 hours per inch are produced, which give a life of 150 to 200 hours for the 8-in. electrode. With very little sacrifice of efficiency a life of 500 to 600 hours is produced and such an electrode has about the same life as an incandescent lamp; that is, the arc lamp requires trimming about as often as an incandescent lamp requires renewal. This latter feature, however, while obviously valuable in cases where trimming is difficult, as with lamps in inaccessible places or during protracted strikes, etc., for general illumination is hardly needed, since it would in street lighting give a life of two months; and a street lamp should be looked after oftener than this.

A simple and satisfactory form is an electrode in which the material is compressed as impalpable powder in a thin iron tube, which is then sealed over by the arc.

In the carbon arc lamp the light comes from the incandescent crater of the positive carbon and not from the arc flame. Hence, the arc lengths should be made as short as possible without obstructing the escape of light from the crater. In the magnetite arc, however, no light issues from the terminals, but all the light comes from the arc flame, and an arc length from ¾ to 1⅛ in. is, therefore, most efficient. Furthermore, to give a constant volume of light the arc lengths should be constant. This leads to a feeding mechanism differing from the "floating system" of the carbon arc lamp and much simpler; that is, a feeding device maintaining constant arc length. The operation of the magnetite arc lamp is, therefore, as follows: When the power is put on the lamp, the arc is struck by separating the electrodes to a definite distance, say ⅞ in., and then the electrodes are locked in this position and remain fixed until after some hours or so, by the consumption of the negative electrode, the arc length and thereby the arc voltage has increased sufficiently to operate the feeding mechanism which resets the arc to its original length.

Insurance Features of Street Railway Property.

An important and interesting brochure has been issued by the committee on special hazards and fire record of the National Fire Protection Association devoted to the subject of insurance of street railway property—car barns, car houses, rolling stock, etc. A number of contributors furnish articles and discussions bearing on the topic and several fires are analyzed in detail. The pamphlet is one of 42 quarto pages. Mr. S. H. Lockett, manager of the Insurance Survey Bureau, of Chicago, has a separate article on "Street Railway Property," in which a number of points are discussed. In his introductory remarks he says:

Losses in this class have attracted a great deal of attention to it, and a few words regarding the business may not be amiss. The days of the old horse car are so nearly numbered that horse car barns and systems are hardly worthy of consideration as a class. Indeed, cable lines are also fast disappearing, or, at least, are numerically and in value unimportant as compared to electric, so that underwriters will have to concern themselves principally with trolley and storage battery systems in the future. The retirement of horse and cable systems, however, will have its effect for some time upon the moral hazard of the entire class, and the acceptance of the surviving cable and horse systems, or such systems undergoing a transition to electric motive power, should involve the consideration of many facts. It must not be overlooked also that the adaptation of old systems to new conditions has as well an appreciable effect upon the physical hazard of the class. Large first cost makes the installation of new cable lines rare, and, owing to the increasing difficulties in municipal streets, this first cost is augmenting to such an extent that the building of cable lines is uninviting as a business proposition. This being true, the second-hand value of cable cars is becoming less, and there is a patent moral hazard attached to their insurance. Physically, there has been a marked unsuitability of old horse car barns for electric car storage purposes. This has been due to several facts. Electric cars are larger and longer, necessitating different track and post arrangements. They are also more numerous on the same lines, since traffic has increased with the greater speed and consequent mileage coverable, and the old barns proved too small. Again, the repairs on electric cars are more frequent than in the case of horse cars, owing to the greater number and size of horse cars, as well as their speed, longer travel and the constant increase of general urban and municipal traffic, which are bound to make wear and tear and accidents more excessive. These repairs have resulted in many new processes and hazards which cannot be accommodated in the old buildings. Yet again, owners themselves have appreciated the undesirability of exposing larger values in the later cars to the ill arrangements and poor construction of the old barns which, in many cases, were converted to car barns during the precarious infancy of street traction enterprises. To a somewhat less extent the above remarks are true of cable systems. There is still much poor construction in progress, more particularly in the case of interurban systems handicapped financially and banking on the future increase of business between growing communities, but it will be found that the record of street railways as a class will be much better than it has been, partly because they have passed the nascent stage and are sounder institutions, anxious to prevent the interruption of their business by fire, and partly because of the insistence of insurance companies upon better construction and practices. The business is heir to some ills, however, for which there is no panacea and seemingly no anaesthetic. Not the least of these is the immense area of the barns made necessary by the number and size of the cars

and the exigencies of street railway service. The mutual exposure under a common roof of several valuable buildings on wheels, as it were, making any barn fire a sort of conflagration, is another ill which, however, may be cured by the introduction, as is done on the steam roads in some cases, of steel cars. Another ill for which there is a definite remedy, not heretofore applied, is the poor wiring and heating arrangements of the individual cars, each one of which is more valuable than the average dwelling in which such arrangements would not be tolerated. As an evidence of the importance of this one feature it is a fact, according to the United States Census report of 1902, that 50 per cent. of all the street cars in use were heated and 90 per cent. lighted; of those lighted 90 per cent. and of those heated 63 per cent. used electricity. As the bad car lighting and heating arrangements are practically universal as far as electrical equipment is concerned, it is plain that the conditions are worse than if a number of frame dwellings with poor wiring and heating arrangements exposed one another, since there is always a good chance of confining a fire to one building, whereas the destruction of one housed car nearly always means the loss of all. Unfortunately, we have not regarded car barns as we do conflagration districts, otherwise car builders would long ago have been required to equip their cars electrically and otherwise in accordance with the best accepted practices.

As affecting the chances of litigation and, consequently, the financial obligations under which a road may have to stagger, statistics show that one person is killed per annum at the present time for each 55 cars in use, or one for each 4,000,000 rides taken. The non-fatal accidents are one for each 101,000 rides, these figures including passengers and others injured, say, in collisions, wrecks, run-overs, etc. It is quite evident, therefore, that a company doing a fair business will be more or less involved in suits, and for this reason the acceptance of large lines should be accompanied by an investigation into existing litigation and into circumstances likely to affect future litigation of this sort. Investigation would naturally be made into other matters affecting the moral hazard, especially in the case of new enterprises where disgruntled persons on the right of way, condemnation proceedings and similar forces must not be neglected. It would appear in this connection, for instance, that lines operating in rural districts, while less subject than municipal roads to accidents, in proportion to mileage, number of cars operated and passengers carried, are not freer from suits of various sorts because of the notoriously litigious spirit pervading the bucolic soul.

The Electrification of the New York Central.

A few months ago, upon the occasion of the announcement of the intention of the New York Central & Hudson River Railroad Company to adopt electricity for the Atlantic seaboard end of its system, we took occasion, in commending this progressive plan, to outline the reasons which we assumed were influencing the management, and which had governed the decision of the engineering staff and the consulting engineers. While to the electrical public such a decision, momentous as it is on the part of a great railroad, appears inevitable, there is no doubt that to a great many of the leading steam railroad officials of the country the determination reached seemed more or less hazardous, while even in electrical circles there was agreeable surprise at the fact that the company, instead of restricting electricity to its Manhattan terminals, had resolved to extend the electric zone as far out as Croton and White Plains. In other words, the action of the New York Central Company was presented in somewhat sharp contrast to that of the Pennsylvania Railroad Company, which, instead of going, as well it might apparently, just as far out on the Jersey meadows with its electrical facilities—say 30 or 40 miles—is restricting the use of electricity to a very narrow zone of four or five miles adjacent to the new station, i. e., virtually for the tunnel under the North River alone, inclusive, one might say, of the tunnel to Long Island also.

Whenever Vice-President Wilgus and his consulting staff make public the details of their elaborate study of this problem, either in the columns of the technical press or before some of the technical societies, it will necessarily constitute a most interesting, vital and valuable elucidation of the present status of steam and electricity in the field of locomotion; and it is to be hoped that they may soon feel at liberty to take the engineering profession at large into their confidence. Meantime, however, we believe we do not overstep the bounds in presenting briefly what we gather to have been the reasons for this remarkable extension of the electrical zone by the New York Central, so that for two-score miles out both the suburban and through trains on the system are soon to be handled exclusively by electric locomotives, data in regard to which have already been presented in our columns. So far as we can ascertain, the main considerations upon which Mr. Wilgus and his board had to predicate their noteworthy conclusions were (1) compliance with the law in the region south of the Harlem River—i. e., Manhattan Island—and the probability of other restrictive measures applying as far out as Yonkers and Mount Vernon; (2) the peculiar topography of the region in the vicinity of New York as well as the very high cost of land, both causes pushing the location of the power plant and other facilities to the outer limits of what might be regarded as the suburban region; (3) the desire to secure opportunities for increasing traffic by means of greater speed, smaller units, more frequent service, suppression of smoke, cinders, noise, gas and a more attractive régime in general than would have been found possible so long as steam was adhered to; (4) minimization of annoyances, loss of time, congestion and dangers on account of changing motive power or changing passengers on suburban trains, etc.; (5) development of profitable long haul passenger and freight business due to the inevitable filling up of the whole region north of New York, which, for lack of transportation facilities had been checked in a growth at all comparable with that which has been enjoyed in the suburban regions of New Jersey, such as the Oranges, Englewood, Plainfield, etc.; (6) an underlying reason, probably, that the creation of its own electric service within the suburban area would release the company from the pressure of competition which would unquestionably arise otherwise from competitive rapid transit lines.

It is evident from the most cursory study of these main considerations that once the change to electricity in any extent was agreed upon, the cogency of the arguments in its favor became more and more pressing; and it is creditable to the courage and mental grasp of the men dealing with the problem that they are willing to carry the proposition with all it involves through to the logical and, one might well say, inevitable conclusion. The more one looks into the subject the more evident it becomes that at such points as Croton and North White Plains the best available facilities are now to be had for making the change from steam locomotives to electricity, while the bids and designs submitted as to the electric locomotives remove the earlier operative objections as to the high cost and inability to handle heavy loads at high speeds. It is not only a great thing for the company thus to rid itself of the combined or conjoint electric and steam terminus with consequent double equipment, but it is really a splendid boon for the whole region to be released from the disagreeable features incident to steam traction and to realize at one sweep all the benefits of electric traction in suburban traffic as well as in the through part of the service. In fact, whatever may be the gain connected with the through service, we are very much of the conviction that, foresighted as the staff has shown itself to be, it will be more than agreeably surprised to watch the beneficial results in the upgrowth of new suburban business. The region north of New York is admirably suited for residential purposes, and with the availability of electric facilities, must develop enormously, especialy as all the serious objections entertained toward the old tunnel at the New York end will be abolished. What electricity can do in the general increase of traffic has been shown on Manhattan Island, and the wider area referred to is, after all, a constituent and integral part of the same region, and should indeed have been annexed residentially to New York long ago.

It is from such points of view as these that we believe Mr. Wilgus to have addressed his energies to the problem, and we have no hesitation in avowing a belief that he and his advisors will be more than justified by the results. It has required courage of a high order to undertake such vast changes—without parallel in the domain of transportation—but the public of New York and of the country at large will in a few years have abundant warrant to congratulate itself upon the revolution; while the large capital necessary for such work on this broad plane will not only have recouped itself, but have done much to increase the yield of the older investment. Moreover, it is very encouraging to know that we are not dealing with a project to be carried out at some time or other, but one upon which the necessary work is now being pushed with great energy and vigor.

Storage Battery Plate Construction With Special Reference to High Discharge Characteristics.

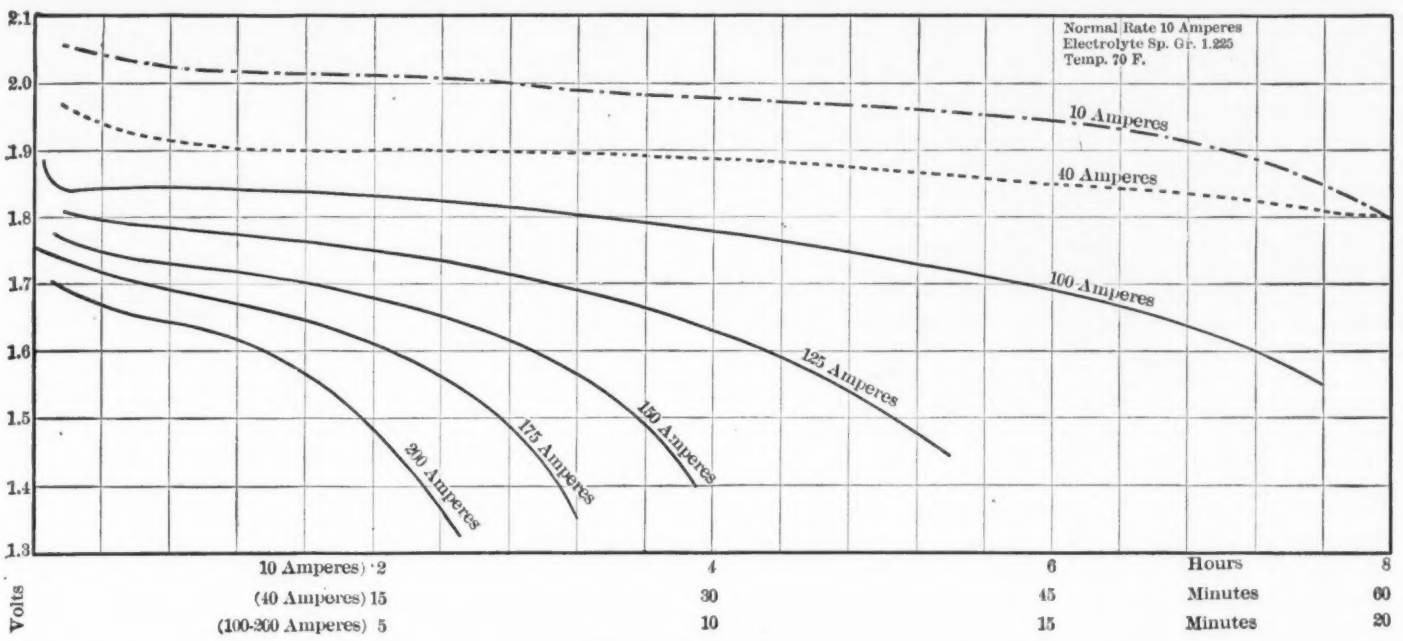
BY W. W. DONALDSON.

THE constantly increasing use and adaptation of electric storage batteries and the proved economy resulting, have had the effect of making electrical engineers look more closely into the features of the plate construction of lead batteries. Although the detailed characteristics are of importance to whatever form of work and conditions batteries are subjected, when high discharge rates are used, the question becomes a much more complicated one than when normal rates are the rule. The largest field in stationary work where abnormal discharges are required is where batteries are used to take the peaks of rapidly fluctuating currents, and these conditions are much more frequently met with in the operation of electric railways. The normal ampere-hour capacity of storage batteries is usually based on a rate which will be maintained for a period of eight hours within an economic voltage range. Such a basis is merely an arbitrary one, as the true practical capacity is when there will be no increase made by further reduction in the discharge rate. This "limit of capacity" is reached much sooner in certain forms of plates than in others, and it is this limitation point which is a direct indication of the superiority of one type of plate over another for watt capacity at high discharge rates.

High discharge rate applications have so multiplied and the storage battery is of so much value for such work that the energies of inventors and of the manufacturers of batteries are being directed toward producing plates in which the "time limit of capacity" is small and inversely, the "rate limit of capacity" is large. At the present time the so-called high discharge rate is four times the normal or eight-hour rate, and the time during which such a rate may be maintained within an economic voltage range, varies from 50 to 70 minutes in different types of plates. If one hour be taken as a mean, then the capacity in ampere-hours is 50 per cent. of the eight-hour capacity. Installations are now made on the hour basis of discharge with allowable "instantaneous" discharges of 50 per cent. additional or six times the normal eight-hour rate. In railway installations where the battery is simply used to take the peaks of short duration, even the full hour capacity is never used. A 20-minute capacity at the same rate of discharge would fulfill all the requirements as far as regulation goes.

Considered as a reserve source of current, the capacity of batteries as installed on their present basis, would be a mere drop in the bucket in supplying current for the operation of a road. In some cases this reserve is found to be of advantage, but in the majority of installations the reduction in first and maintenance cost, if batteries of one-half the present size were used, would much more than compensate for the reserve feature. It must be remembered also that in fluctuating work, the "floating voltage," the point at which the battery stands when neither charging nor discharging, is at the most efficient point when it changes least on charge and discharge, and this is found to be when the battery is three-quarters full. This of course varies with different types, the object being to produce a plate with an efficient floating voltage when it is in as near a charged state as possible. Taking the three-quarter state of charge as the operative condition, the actual effective capacity of batteries for this work is then thirty-seven and one-half per cent. of the eight-hour capacity. Such a state of affairs must conduce to investigation and improvement. Advance in plate construction must result in either increasing the ratio of useful to actual capacity in ampere-hours, or, letting this ratio stand, increasing the discharge rate for shorter periods of time, without shortening the effective life. The discharge curves given below are from a well-known type of plate and show the effective voltage and current capacity for periods of from five minutes to eight hours.

The question arises to what extent and in what ratio will the life be affected by discharging for short periods at these various rates, and whether the greater discharge output than at present used, together with relative decrease first cost and interest charges would more than offset the greater depreciation, should it occur. There should be two types of plates, one designed for two and one hour rates of discharge and with large capacity, and the others for twenty and ten-minute rates, and with relatively small capacity. The latter type of plate is the one which offers the greatest field for the investigator. A plate properly constructed for even moderate rates, should not greatly depreciate when discharged at eight times the normal for short duration peaks, and at twelve times for "instantaneous" peaks. By depreciation is meant not only that the structure of the plate should be preserved, but that the ampere-hour and voltage range should not be lowered. Many plates will, after long use, still be in good condition as far as their structure goes, but will have lost capacity. Structure must be maintained to insure capacity, but properly maintained capacity is bound to be accompanied to a limited extent by a weakening of the structure. The best plate is the one which, towards the end of its useful period, goes to pieces very rapidly and loses its mechanical and electrical efficiency simultaneously. It is the "electrical" characteristics which should have the first consideration in the design. "Provide for good electrical conditions and the mechanical will take care of themselves."



DISCHARGE CURVES.

In considering the construction of plates best adapted to high discharge work, the positive and negative must be considered separately. The fundamental requirement for both plates is that their active material must be formed by an electrochemical action. No paste or applied active material should enter into the construction of either plate for stationary high discharge work. Considering the positive or electronegative grid first, this should be "integral"; that is, no mechanical or autogenous joints should be present. The plate must not be "built up" of separate parts, nor should the active material be relied on as a conductor of current derived from other but its own reaction; that is, no extraneous current should pass

through it. Time and use always affect such contacts, and loss of capacity follows. No other metal save pure lead should be used, mixtures and alloys always complicating and retarding the proper chemical actions. "Casting" of the basic plate should be avoided, as hard rolled lead gives a density and homogeneity far superior to cast metal.

Of whatever form the plate may be, a "center web" or conductor is necessary for the most even distribution of current, this central conductor in a well-constructed plate never being subjected to the reversals due to charge and discharge unless a very complete discharge at very low rates is used. Rigidity, in excess of that required for proper electrical conditions, need only be provided for in direct ratio to the total weight of the plate. Any allowance beyond this reduces the percentage of effective active support. The "main" conducting and supporting frame, which should never be counted on for any active formation, should not exceed 15 per cent. of the weight of the plate proper, and this, with 10 per cent. in addition (the residue of the "active support") should be all that remains of lead when the plate has lost its useful capacity; that is, a total of 25 per cent. of the original weight of metallic lead. The "basic convertible active lead" should be initially about 85 per cent. of the weight of the plate proper, and all but about 14 per cent. of this should be convertible into the active agent, peroxide of lead. The support area for the active material contact should be not less than 175 sq. in. per pound of plate proper, and should not be greater than 250 sq. in. per pound of support contact; that is, the thickness of this support contact after formation should not be less than 20/1000 of an inch, which allows 10/1000 as a conductor for each layer of active material.

One of the most important, in fact it might almost be said the most important, factor of a plate for such work as we are considering, is that the metallic contact of the active material support with the main conducting frame should be of such a character as not to be impaired or lessened by any action due to subsequent formation of active material. Too much stress cannot be laid on this requirement. As much of the surface of the active material support as possible should be bathed by free electrolyte, and provision be made for vertical capillary diffusion, rather than for horizontal or through-and-through circulation. The active material support surface presented for discharge action should not be less than 33 sq. in. per ampere, for a rate corresponding to eight times the normal. The plate as a whole should be as thin as is consistent and should not exceed one-half inch from face to face. Provision for the retention of the active material must be such that its dislodgement cannot be accomplished by the formation and expulsion of any of the gases incident to the chemical actions or by the change in volume due to its conversion.

Having now covered in a general way the positive support plate, we should consider the active material, peroxide of lead. As it is impossible by the use of applied active material to produce a plate to meet the requirements as to life in high discharge work, this material must be formed electrochemically by some such method as charging continuously at a pressure considerably below two volts, as by the Planté method of charging and discharging and reversing in acid solutions above two volts, or by charging in forming solutions which act directly on the lead itself, producing nitrites, and sulphates and oxides of lead, which are in turn peroxidized by the action of the current. The last method being the cheapest is usually employed.

One requirement for high discharge work is that the active material must be in the form of a very thin layer and should not exceed 8/1000 of an inch in thickness, with a conducting backing 25 per cent. greater or 10/1000 of an inch thick. Such a layer would correspond to .8 of one cubic inch of peroxide per 100 sq. in. of contact support, or (allowing 2.1 ounces per cubic inch) 1.68 ounces per 100 sq. in. This volume of peroxide at a capacity of 2.5 ampere-hours per ounce will give 4.2 ampere-hours per 100 sq. in. at a normal rate of discharge. The weight and capacity per cubic inch of peroxide vary greatly, but these figures are conservative and are easily followed. The ratio of weight of active material to active support should be as 1 to 1.9 (approximately 33⅓ per cent.) and the active material should not be over 18 per cent. of the weight of the plate proper. The porosity, granular and molecular, should be such as to allow the mass of the active material to hold at least its own weight of electrolyte and thus allow for good diffusion of the acid.

Diffusion is necessary for the chemical combinations and consequent production of current, the e.m.f. of the positive plate on discharge being a function of acid concentration. The greater the surface exposed to acid, the better the diffusion, if details of structure are proper. If the peroxide of lead is formed from the basic lead support, it becomes part and parcel of it and the two are knitted firmly together in intimate contact. After time and use this cohesion becomes impaired unless the arrangement of the grid is such as to maintain a constant pressure of the active material against its lead support. If such pressure be maintained and the active material held firmly in place, the tendency for further peroxidization of the support is greatly lessened; and if the formation has been properly carried on, there is a protective coating so dense as to almost stop further action if the original outside layer maintains its proper position relative to the support.

The laws governing the construction of the negative basic plate for high discharge work are the same as for the positive except that there need be no provision made for the formation of active material subsequent to the initial deposit, nor need the current-carrying capacity of the active support be as large. The plate should be integral and of pure lead, alloys causing increased local action with the active material, and local action is one of the chief causes of capacity loss in many forms of negatives. Active contact support should be at least 300 sq. in. per pound of plate proper and grid support 40 per cent. of total weight of plate proper. The support contact should be not less than one-third that of the active material in thickness. The number of square inches of contact support per ampere of discharge should be no less than in the positive, and although the negative plate is, as a whole, of much lower resistance than the positive, a central diaphragm or wet conductor is of value as the principal starting point and distributor of current. One all important necessity of the negative grid is that it should be made in such a way that not more than 10 per cent. of its superficial area be exposed to the electrolyte; less than this amount is even advisable, as the larger the surface of the active material which is bathed by free acid the better will be the maintenance of the negative voltage on high discharge work.

Provision for the retention of the active material forms a chief factor, as dislodgment is very apt to occur by the force of gas accumulation and expulsion, and loss of this kind in the negative cannot be compensated for by further formation as in the positive. This retention of the original volume of negative active material is one of the most difficult things to accomplish. Various, one might say "artificial," methods have been resorted to, but such methods are, as a rule, make-shifts and in the end react badly on acid diffusion and consequently affect voltage. If the proper electrical conditions of the negative plate are adhered to, the mechanical strength will take care of itself. Efficient negative active material, finely divided spongy lead, can be produced by the same methods as explained in connection with positive material. Negatives with applied active material are the most popular and cheapest to prepare, but the "life is not in them" in comparison with those electrochemically formed. The molecluar porosity of spongy lead should be such that it contains at least twice its volume of acid, although this ratio can be increased if the design of the plate should warrant it. Spongy lead does not thrive in strong acid, so every provision possible must be made for acid diffusion and renewal in the pores.

The volume of material should not exceed one cubic inch to each 100 sq. in. of support contact, and the capacity should not be less at normal rates than 4 amp.-hours per cubic inch. In a correctly designed plate this should give 15 amp.-hours per pound of plate proper. Such should be the initial capacity of the negative, but only 60 per cent. of this should be used; that is, the capacity of the positive should be 60 per cent. of the negative, so that the capacity output is limited by the positive, as working negatives down to low voltages is very deleterious, increasing largely local action. There is another reason for having a surplus increased capacity in the negative, which is that as time goes on, there is a shrinkage and molecular change, the former causing a loss of mechanical and electrical connection of the active material with the support, which, together with the molecular change, causes loss in capacity. If the active material be formed from the lead plate itself, it is part and parcel of it and is in continual intimate contact, so that any loss in capacity which occurs should be charged to the molecular change. When from either of these two causes or from both, too great a capacity loss occurs, the plate should be capable of complete reversal and reformation without injury or loss of active material. The life of the negative plate is generally held to be twice that of the positive (what is meant by

"life" being rather an unknown quantity); but there is no reason why this ratio should not be more than doubled if strict and scientific principles are adhered to in the construction.

As I stated at first, electrical engineers and those directly interested in the use of storage batteries would find their time well repaid if they searched for strong and weak points in plates which they contemplated buying, with the same ardor they expended on the other parts of electrical equipments.

Annual Meeting of the American Institute of Electrical Engineers.

The annual meeting of the Institute was held in New York City at the Chemists' Club on May 17 and 18. In view of the fact that the Institute will take so prominent a part in connection with the Electrical Congress at St. Louis in September, the directors did not lay out a very extensive programme. This would explain the small attendance of members—the number at no time exceeding 150.

On Tuesday morning, May 17, papers were presented to Mr. W. L. Waters on the "Predetermination of Sparking in Direct-Current Machinery"; by Mr. E. H. Anderson on the "Effect of Self-Induction on Railway Motors," and by Dr. W. E. Winship on the "Calculation of Line Batteries." The reading of these and the discussion which followed lasted until 1.30 P.M., when lunch was served. There was no regular meeting in the afternoon, but on the invitation of the Interborough Company the members visited in a body the Rapid Transit Subway, entering at Columbus Circle and Fifty-ninth Street and walking down the track to Fiftieth Street, from which point a visit was made to the sub-station at Fifty-third Street. Members were received by Messrs. L. B. Stillwell and H. G. Stott, who explained many features of the work. The subway was found in a well advanced condition, but doubts were expressed whether it could be ready before late fall, especially as all the rolling stock has to be got into operation.

At the evening meeting the result of the annual election was declared, on the report of the tellers. The successful candidates were as follows: President, Mr. John W. Lieb, Jr.; vice-presidents, Prof. W. E. Goldsborough, J. J. Carty, Col. S. Reber; managers, Messrs. H. G. Stott, L. A. Ferguson, J. G. White and Dr. S. S. Wheeler; secretary, Mr. Ralph W. Pope; treasurer, Mr. G. A. Hamilton. The report of the board of directors was then read, showing that the growth of membership had been maintained. The total May 1, 1903, was 2,229, and the net total of membership April 30, 1904, was 3,027. The ordinary receipts of the Institute during the year had reached the substintial sum of $40,986, and a balance was shown of $4,592. After making various allowances and deductions to funds, the net balance in cash or its equivalent of $12,337 was shown to be immediately available for any ordinary or unusual expense of the Institute. The balance sheet showed the finance committee to have done excellent work and the Institute to be in thoroughly sound and prosperous condition. The inventory value of the library, as shown in the report of the library committee, was increased to $21,737, the former valuation having been based upon a nominal valuation for insurance. A sum of $3,118.75 was expended upon the library during the year. With regard to the local organizations, in respect to which Mr. C. F. Scott made a further separate report during the evening, it was shown that there are at present twenty-nine Institute branches, fifteen of which are in cities and fourteen students' meetings in technical schools. The aggregate attendance at such meetings is 1,250, about 400 being students. With respect to the Electrical Congress, the details already given out were repeated, and it was stated that at the time of the report the Congress subscribers numbered about 1,600, while 157 papers had been promised from leaders in the profession. It was also stated with regard to the adoption of a standard cell that this matter will be submitted to the International Electrical Congress, and that the cadmium cell of Mr. Weston is proposed as a universally recognized standard. Details were also given as to the Union Engineering Building, and condition of the project; and supplementing the statement in the report, Mr. Calvin Rice, chairman of the building committee, was able to state that already $47,200 had been pledged and that the work of the committee was being actively pushed.

As an instance of the *esprit de corps* existing in the Institute, it was stated that Boston had pledged its best efforts, while the local section in Iowa had already sent in the generous subscription of $600. It may be added that on Wednesday Mr. Arnold, at the morning session, announced amid considerable applause that Mr. Edison had just given $5,000 to the fund, bringing it well above the $50,000 mark. Since then, a subscription from Dr. M. I. Pupin of $5,000 has been announced, and before the meeting closed the fund was above $60,000.

With regard to meetings, it was stated that the annual convention at Niagara Falls in 1903 had brought out an attendance of nearly 500 members and guests. It was also stated that preparations were being made for a special meeting at Chicago on June 21 and 22 to be devoted exclusively to transmission subjects.

A paper was presented during the evening by Mr. B. G. Lamme on data and tests on 10,000-cycle per second alternators.

The session on Wednesday morning was followed by luncheon, and the afternoon was spent in a visit to the library and technical laboratory of the Columbia University under the guidance of Profs. F. B. Crocker and George F. Sever.

Mr. John William Lieb, Jr., the new president, was born in Newark, N. J., February 12, 1860, he attended the Newark Academy and the Stevens High School, Hoboken, N. J., and graduated from the Stevens Institute of Technology in 1880 with the degree of mechanical engineer. In 1880 he engaged as draughtsman with the Brush Electric Company in Cleveland. He entered the employ of the Edison Electric Light Company, New York, in 1881, as draughtsman, and was transferred to the experimental department at the Edison machine works in 1882. He assisted in the tests of the first "Jumbo" direct-connected Edison dynamo, and by Mr. Edison was put in charge of the installation of the electrical equipment of the old Pearl Street Edison station, under the direction of Mr. C. L.

J. W. LIEB, JR., PRESIDENT-ELECT, A. I. E. E.

Clarke, chief engineer. He also assisted in the tests and experiments incident to the starting up of that pioneer station, the first commercial station in the United States supplying current for incandescent lighting and power from an underground system. On the inauguration of regular service, September 4, 1882, under the auspices of the Edison Electric Illuminating Company of New York, Mr. Lieb was appointed its first electrician.

A syndicate of Italian capitalists with Prof. Colombo as technical adviser, having purchased a complete equipment of boilers, engines, dynamos and Edison underground system for Milan, Italy, Mr. Lieb was selected and dispatched by Mr. Edison to direct the installation. The Milan station, equipped with Babcock & Wilcox boilers—six 150-hp Armington & Sims engines and Edison "Jumbo" dynamos, began regular service in 1883 and Mr. Lieb remained in charge as manager on the organization of the Italian Edison Company. He was appointed in turn its chief electrician, director of stations and chief engineer in general charge of the technical department of the company, engaged in manufacturing electrical apparatus, installing isolated plants and constructing and operating lighting and power stations throughout Italy. Mr. Lieb's company was among the very first to exploit the alternating-current system, beginning with a plant in Milan, Italy, in 1886, and using also the Thomson-Houston arc system extensively. His last work in Italy was in the electric railway field in connection with the installation of the trolley system in the city of Milan.

Being offered an appointment with his old company—the Edison Electric Illuminating Company of New York—Mr. Lieb returned home in 1894, at first in the capacity of assistant to the first vice-president and advancing by steps to third vice-president and general manager. On the consolidation of various lighting interests in New York City, under the corporate name of the New York Edison Com-

pany, he was appointed third vice-president and associate general manager, which position he now holds. He is also president of the Lamp Testing Bureau and director in several electrical corporations.

Mr. Lieb is a vice-president of the American Institute of Electrical Engineers, member of council of the American Society of Mechanical Engineers, member of the American Society of Civil Engineers, past president of the Association of Edison Illuminating Companies, past president of the New York Electrical Society, second vice-president of the National Electric Light Association, member of the Associazione Elettrotecnica Italiano, Franklin Institute, American Academy of Political Science and the Engineers' Club of New York City. He is also chairman of the general reception committee of the Institute for the International Electrical Congress.

Below are brief abstracts of the several papers. An abstract of the discussion will be given in the following issue.

Mr. W. L. Waters read a paper on "Predetermination of Sparking in Direct-Current Machines," in which he pointed out the insufficiency of a theory of commutation based on reactance voltage without accounting for other factors entering, and showed that the design of a direct-currentd machine with respect to sparking is a compromise between a number of conflicting conditions. A formula is developed in the paper which is stated to include all the important factors affecting sparking; and while empirical, it has been gradually built up as the result of experience, different terms having been added from time to time to take different conditions into account. It does not, however, take into account all the conditions that affect sparking, and one is cautioned that it must be used with considerable discretion.

"Effect of Self-Induction on Railway Motor Commutation" was the title of a paper read by Mr. E. H. Anderson, the subject matter being based upon a study of oscillograph records, of which 13 are photographically reproduced in the paper. The fundamental causes of sparking are stated to be, first, the interruption of the line current flowing through the conductors connected to two adjacent commutator bars; and, second, the interruption of a local current produced by a voltage generated in the conductors connected to the commutator bars which lie under the brushes, this voltage being due to the shifting of the field caused by the armature magnetizing effect, and is influenced somewhat by the voltage per bar of the motor. The voltage from this latter cause is additive to the first mentioned or reactance voltage of commutator based upon line current. The local current should be cut down as much as possible, and consequently railway motors have, as a rule, low armature turns and very high flux and field turns compared with those used in the direct-current generator. Since in large motors the local copper circuit is of low reactance as compared with the brush contact, nearly all the energy of the local current is delivered as heat on the commutator. Should the motor be very large, the stability of the field relatively to the armature must be great in order to limit the local current to a low value, as otherwise the motor will spark and glow at the brushes. On the other hand, in small machines the resistance of the local copper circuit may be high compared to the carbon contact resistance.

Stability of flux is quite essential to good commutation, and this may be secured by the usual method of great saturation or by compensating for the distributing element by means of armature reaction. The latter method points to a motor with distributed winding of the field, pole pieces of great pitch, equal density over the pole face and relatively few turns.

The paper refers to experiments with large direct-current motors, which motors have a tendency to flash when running at free speeds and light currents, the current being interrupted and contact restored again with full pressure across the motors. It is found that motors with exceedingly good commutation at normal loads or on overloads at rated pressure, and even motors which commutate without flashing over with full load current at double-load voltage, have a peculiar tendency to flash over when the current is changed rapidly or the circuit interrupted and made again with full pressure on the motors. Two causes are given for this, one a transformer pressure induced in the armature coils lying under the brushes owing to the rapid change of current, thereby causing large local currents to flow in the coils and through the brush contact. On interrupting this current as the coil passes from under the brush, there is a flash between bars and the line current will follow this local brush from bar to bar. The predominating cause, however, is the slowness of the main flux to respond to excitation, thereby allowing a great rush of current. The paper gives in detail a number of tests made in the study of this phenomenon, but no remedy for its ill effects is offered..

The papers of Messrs. Waters and Anderson were discussed at length by Messrs. E. R. Douglas and Thorburn Reid, both of whom entered with much detail into the various phenomena of commutation, their cause and the manner in which their effects may be met.

Mr. W. E. Winship presented a paper entitled "The Calculation of Line Batteries," in which formulas are deduced for the calculation of storage batteries for use in electric railway work, and with particular reference to "floating" batteries. It is stated that the capacity of a battery should be reckoned approximately at the rate corresponding to the duration of all the net discharges and not at the rates at which the separate discharges occur. This follows from the reason that if a battery is discharged at a high rate for a short time and then is allowed to recover, and the same cycle is repeated a number of times, the ampere-hour capacity of the battery very nearly approximates the capacity at the rate corresponding to the total time elapsing.

In addition to the method of calculation presented, it is stated that comparative calculations should also be made considering, first, the cost of copper alone, and the cost of copper and batteries for equivalent line voltages; also the cost and depreciation in the two cases together with the transmission losses. The battery should be credited with the influence which the load equalization affected would have on the cost of power production; and the emergency value of the battery in case of temporary break-down should receive consideration. With fairly long lines, the ends of which are 6 to 10 or 12 miles distant from the power house, and the cars running are relatively few in number and heavy, a battery installation will generally cost less than equivalent copper. If there are grades and the cars stop and start at a distance from the power house, the value of the battery as a load equalizer will nearly always justify its installation.

Mr. B. G. Lamme presented a paper entitled "Data and Tests of a 10,000-cycle-per-second Alternator," which describes the construction and test of a 2-kw, 150-volt, 10,000-cycle alternator designed and constructed at the Westinghouse works for M. Maurice Leblanc for use in certain special telephone work.

Mr. H. H. Barnes presented a paper entitled "Notes on Fly Wheels," in which he considered the subject from the standpoint of electrical generation. A formula is given for the calculation of a fly-wheel, taking into consideration the avoidance of resonance. The main conclusions are that the fly-wheel, as distinct from the assistance given either by the engine governor or the damping of the unit, is impotent to insure satisfactorily synchronous operation. Except for these two influences the tendency toward accumulative surging existing in the unit would predominate and parallel running would be impossible. A somewhat lighter fly-wheel is advisable than would be considered conservative in practice to-day. Electro-mechanical resonance is a serious danger that must be avoided by making a proper choice of fly-wheel, which should at the same time be satisfactory for general operating purposes.

Prof. W. S. Franklin read a paper entitled "The Single-Phase Induction Motor," in which is discussed the various factors entering into design, and formulas deduced for the calculation of such a motor.

Mr. George H. Rowe, in a paper entitled "Wave Form Variations of a Long-Distance Line," gave an account of a study of the lines of the Standard Electric Company, California, made by means of the oscillograph. The paper contains a number of reproductions of records taken with the oscillograph, which is stated to offer the best means of studying variations in wave form, amplitude factor, surgings, pumping, etc. The best form for this work is the moving film or falling-plate type, without a synchronous motor attachment; and it should be insulated for use in high pressures and fitted with non-inductive metallic resistances. Among the conclusions of the paper are that it is advisable to substitute induction motors for synchronous motors on lines with large charging current, the latter being used as synchronous compensators properly distributed. It is impossible to design machines to satisfy all wave forms, and the variation in amplitude factor in a long line must be considered. The core loss variation should also be considered, and the charging current may differ from that calculated on the assumption of a sine law. Assumption of sine wave form on long lines and applied to insulator and insulation testing may lead to error. The variation of wave form is partly due to the distorting effects of the hysteresis loop under different conditions of load.

The Nernst Lamp.

IN 1897 Prof. Walther Nernst, of the University of Göttengen, filed his first patent application on the principles of the lamp which bears his name, and concurrently rumors concerning the new lamp began to appear in the technical press. It was not, however, until the spring of 1899 that the issue of the first of a series of patents disclosed to the public the main features of the invention, and not until two years later that the detail patents appeared. Almost a year before the issue of the first patent, however, the distinguished German professor on a visit to this country brought his invention to the attention of Mr. George Westinghouse, with the result that the American rights were disposed of; and with characteristic promptitude Mr. Westinghouse at once gathered a technical staff for the development of the new light to the commercial stage.

What has been accomplished by this staff is strikingly illustrated by a comparison of the Nernst lamp of to-day with that illustrated in the early patents. Such a comparison does not, however, involve any reflection on the inventor; as compared, for example, with the problems presented in the development of the incandescent lamp, the difficulties to be overcome in reaching the commercial stage with the Nernst lamp were enormous. In addition to the difficulties of purifying and treating in commercial quantities the component rare earths of the glowers, were problems relating to regulation, preliminary heating and automatic circuit control, and those of another order none the less simple relating to glower terminal connections, and to the numerous constructional details which each step presented for solution. Nevertheless, in but little over a year from the commencement of development in this country, Nernst lamps were in experimental use on commercial circuits, and subsequent work has been largely in the direction of refinement in processes and perfection of mechanical details.

No account of the genesis of the Nernst lamp would be complete without reference to the brilliant and self-absorbing work of the staff to which Mr. Westinghouse confided the task of its commercial development. A partial record of the work of some of these gentlemen is contained in a long list of patents, which are evidence of the masterly manner in which the scores of problems presented were given solution. Where all have given devoted service in a cause, it is embarrassing to discriminate, but none concerned will, I believe, begrudge a major share of credit to Messrs. Alexander J. Wurts, Henry Noel Potter, Marshall W. Hanks, Max von Recklinghausen, Murray C. Beebe and Edward Bennett.

That the Nernst lamp is now a fixed factor in the lighting field appears beyond dispute; and although it has been handicapped as to rate of progress by a conservatism in the central station field in vivid contrast to conditions of ten or more years ago—when merely to be new was a qualification inspiring a fervid welcome—the glower lamp in its present state calls for serious attention on the part of all central station men. In what follows some account, gathered during a recent visit to the Nernst lamp factory, at Pittsburg, will be given of the processes of manufacture of the Nernst lamp, together with a consideration of some of its features of special importance from the operating standpoint.

In view of the little-known nature of the constituents which compose the glower of the Nernst lamp—commonly known as the rare earths and of which the more recently discovered member, radium, has acquired the widest fame—their impurity in native state and the previous almost entire lack of knowledge concerning their treatment in any form, an immense amount of work has doubtless been necessary in arriving at the technical information now in the possession of the manufacturers. The list of rare earths is a long one —numbering almost two score—and it can be imagined that no small labor was involved in testing various combinations thereof, selecting the ones most suitable and determining the best proportions in the combination for a glower. Naturally information of this character is not given publicity, and consequently so far as relates the raw material and its treatment, we are limited in our statements to disclosures in the several Nernst patents.

In one of the earlier Nernst patents it is stated that the mixture which has in high degree the requirements for a glower consists of about 80 parts of oxide of zirconium, 10 parts of oxide of erbium and 10 parts of oxide of yttrium. These are taken in a powdered state, thoroughly mixed, and a paste then formed by adding water and a binding material such as tragacanth or dextrine. In later patents it is stated that very excellent results have been obtained with a mixture of approximately 70 per cent. of oxide of zirconium and 30 per cent. of oxide of yttrium. Other mixtures which are stated to have been used with good advantage are as follows: 10 per cent. of oxide of zirconium, 70 per cent. of oxide of thorium and 20 per cent. of oxide of yttrium; 70 per cent. of oxide of thorium and 30 per cent. of oxide of yttrium; 0.5 per cent. of oxide of cerium, 80 per cent. of oxide of thorium and 19.5 per cent of oxide of yttrium. These percentages, it is stated, may be widely varied, and generally speaking, the oxides of the rare earths are well adapted for use in mixtures in widely varying proportions. The patents also refer to oxide of magnesium as a suitable component.

Describing in the later patents the preparation of the material of the glowers, it is stated that the oxides to be used are thoroughly pulverized and intimately mixed, and a plastic mass then made by the use of a binder of clear starch. The water used in making the paste should preferably be distilled to avoid the presence of lime, which, being more volatile than the oxides of the rare earths, its presence is undesirable. In another connection it is stated that certain of the rare earths are inapplicable for the same reason. The plastic mass is then inserted in a press and forced through a small hole of requisite diameter, this process being the same as used in "squirting" incandescent lamp filaments. The rods or threads thus produced are then allowed to dry, when they acquire sufficient strength to be conveniently handled. It is stated to be desirable that the greatest specific gravity possible shall be given to the material. In the next process, that of heating, it is stated to be desirable for the heat to be gradually applied, but eventually carried to an extremely high degree. Upon cooling, the rods are ready to receive terminal connections.

FIG. I.—A ROOM IN THE CHEMICAL DEPARTMENT.

As previously stated, the processes at present employed in treating the rare earths in their passage from the mineral form in which they are found to the state of glowers, are not given publicity. In general it can be said, however, that the processes involve chemical skill of the most expert kind, and close attention to the minutest detail. In particular, it is extremely necessary that all the chemicals employed as reagents or otherwise shall be absolutely pure. For satisfactory results, the degree of heat applied during the treating process must be exactly controlled, and also the concentration of precipitating solutions.

Though organized for work on a large scale, a walk through the factory laboratory creates the impression that one is being shown the workshop of a splendidly equipped investigator into the minutae of chemistry, instead of a department of a lamp works. One requirement in the processes is absolute cleanliness, and to assist in assuring this, that portion entering the laboratory of the grimy ambient which in Pittsburg passes for atmosphere, undergoes thorough filtration. The refinement of care with respect to the material does not cease, however, in the chemical laboratory proper. Each time that new material is prepared a portion is made into test glowers, which are then mounted as if in lamps, and a careful record of performance kept. The admirable organization of the Nernst works is very well shown in the elaborate records kept of glower material from its crude to final state. By means of this system

every step from the crude material to the finished product is a matter of record, and as a consequence any abnormality can at once be traced to its source. The net result of this system of records and stage tests is to give complete assurance that when once mounted in a lamp, each glower will give the exact performance for which it was destined. In fact, throughout the factory one is everywhere

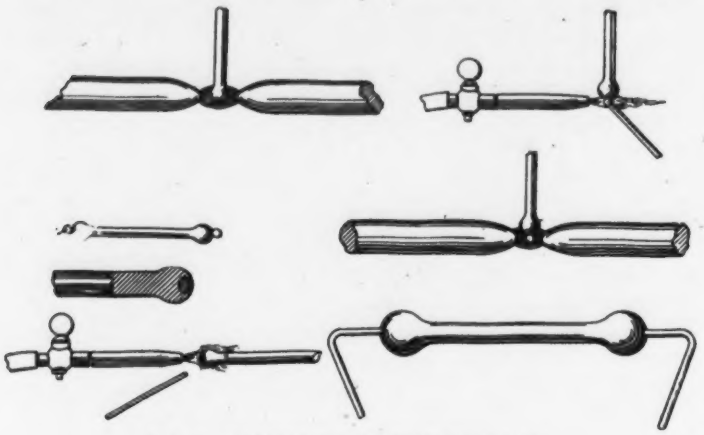
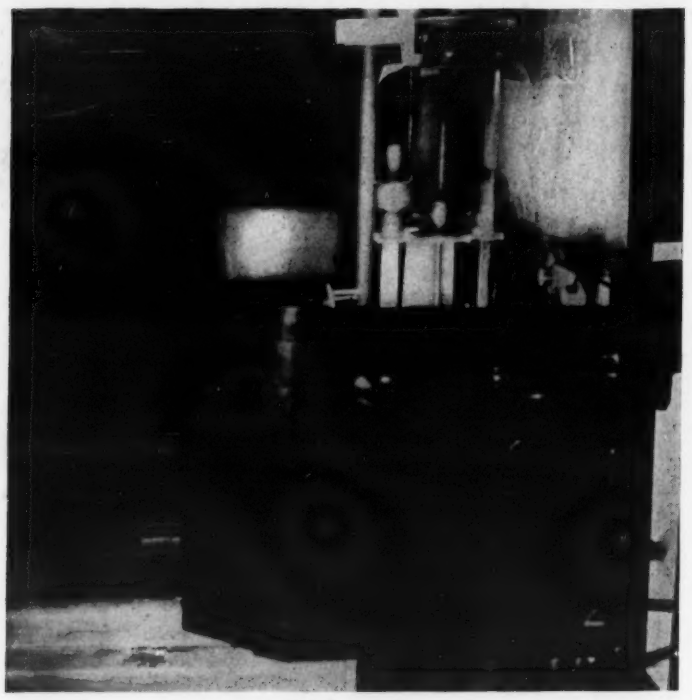
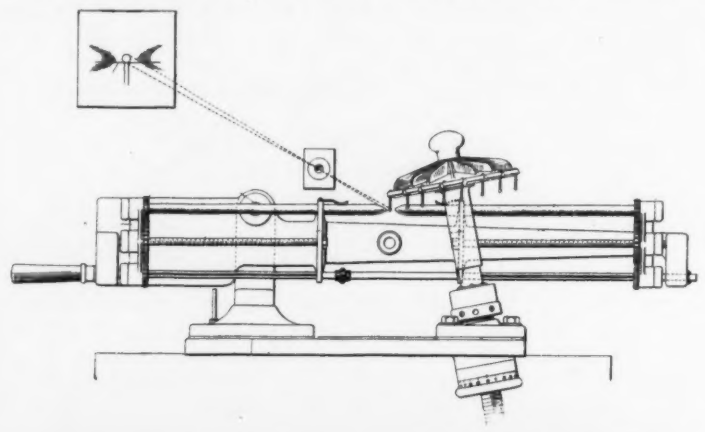


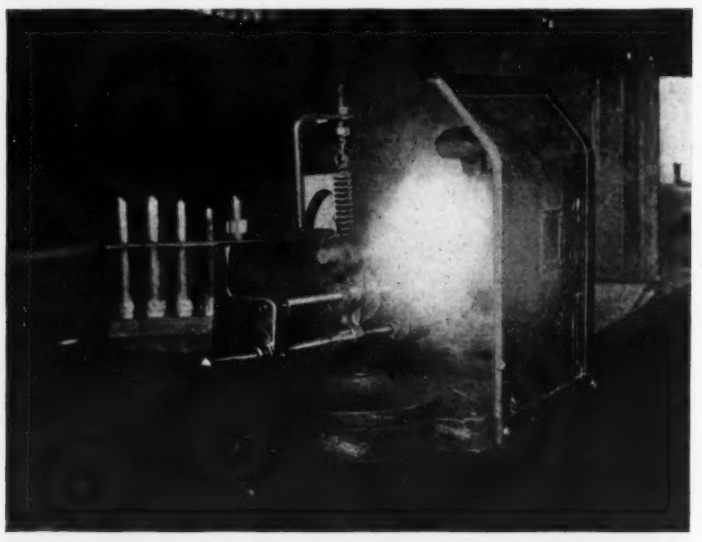
FIG. 2.—PROCESS OF MAKING TERMINALS.

impressed at the extreme care bestowed on that part of its organization which relates to securing exact uniformity of product.

Previous to the description of the process of mounting glowers, some data may here be given as to their dimensions. At normal temperatures practically non-conductors of electric current, when heated the Nernst glower possesses most of the properties of ordinary conductors. An exception is with respect to the method of conduction, but as the electrolytic theory on this point has no bearing on what follows, it may be here ignored. To adapt to different voltages and currents, the cross section and length of the glower is consequently varied as in the case of the incandescent lamp filament. The single filament of a 25-cp., 110-volt lamp has a diameter of .025 in., and a length over all of .62 in., the corresponding dimensions for a 30-cp., 220-volt lamp being .014 in., and 1 in. In the three







FIGS. 3, 4 AND 5.—APPARATUS FOR MAKING GLOWER TERMINALS.

glower, 200-cp., 220-volt lamp these dimensions become .025 in. and 1.18 in., respectively, and .025 in. and 1.18 in. in the six-glower 500-cp., 220-volt lamp. The glowers, while perhaps intrinsically more fragile than the carbon filament, are, owing to their much greater cross section, quite sturdy when mounted and not subject to breakage in ordinary handling.

Perhaps the most troublesome problem presented in the development of the Nernst lamp was in connection with the glower terminals. The final solution as found by Mr. Marshall W. Hanks, consisted of embedding a platinum bead in the end of the glower and fusing to this a platinum terminal wire. Thus the trouble previously met through contraction in the material of the ends, turned to a positive benefit, in that the terminal is thereby more securely held. The rods of glower material are cut to a length somewhat longer than that of two finished glowers. Each end is then heated in turn in an electric arc, and as the material softens the end assumes a spherical shape. Then in an oxyhydrogen flame a platinum wire is plunged for a short distance into the heated globule, when a small portion becomes separated at a point where the wire has been previously nicked, after which the end is again placed in the arc for an instant. To the platinum globule thus embedded in the spherical end is then fused the terminal wire with the aid of an oxyhydrogen flame. The several stages of this operation are illustrated in Fig. 2, but with reference only to a single glower. Finally, the end of the terminal wire is fastened to an aluminum plug which facilitates connection of the glower to the lamp holder.

The most interesting part of this process is, however, that which relates to the manner whereby the second terminal connection of a glower is made. For satisfactory results it is, of course, necessary that the completed glowers of a given rating should be uniform as to resistance, and by means of a beautiful arrangement due to Mr. Marshall W. Hanks, this is as exactly as possible accomplished. Referring to Figs. 3, 4 and 5, it will be seen that a number of glowers are mounted on a revolving stand and the lower ends in turn brought under the influence of an arc between two carbons. A magnified image of the glower and the arc is thrown on a screen in front of the operator, and also the image of a gauge line. As witnessed in actual operation, as soon as the glower treminal comes within the influence of the arc, it is seen to swell and gradually but rapidly an almost perfectly spherical globule forms on the end; as this latter increases in size it approaches the gauge line, and when it becomes tangent with it, the operator revolves the table, the motion withdrawing the glower under operation and introducing another. In a subsequent operation the platinum bead is introduced as above described, and the platinum leading wire fused to this. The entire operation requires but a very short time, an experienced operator being able to turn out 350 glower beads per hour.

While great accuracy is possible in determining the length of the glowers by the above method, it is, of course, not possible in commercial production to prevent some variation in the voltage value of the glowers. The latter therefore have to be sorted before consignment to stock, which operation consists in the measurement of voltage while normal current passes through the glower. Naturally the proper voltage value in this test will be somewhat higher than the corresponding value in the lamp, due to the mutual heating effect of the different glowers in the case of multiple glower lamps, and to the temperature existing within the enclosing globe. In marking the standard packages, containing 10 glowers each, with the voltage of the lamp for which they are suited, it is therefore obvious that allowance must be made for this difference, in addition to 11 per cent. drop in ballast and cutout.

A very neat and original device is used for glower sorting as shown in Fig. 6, having the form of a wheel, the periphery of which carries a number of special mountings for making glower connections in a speedy and positive manner. The wheel is rotated on its axis, commutating connections being made between the glowers and supply circuit. All of the operations, including taking current and voltage measurements, are done by a single operator, the output of each operator being about 1,300 glowers per day.

Before passing to further details of manufacture, a summary may here be given of the organization of the several parts of the Nernst

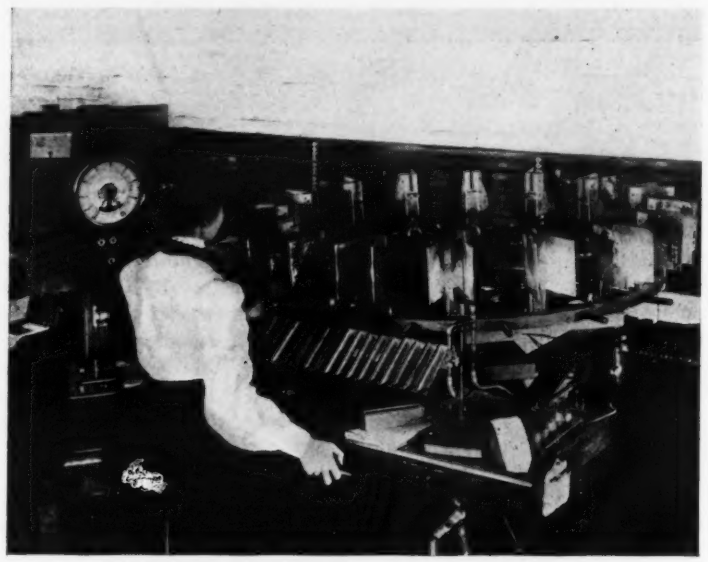


FIG. 6.—TESTING GLOWERS.

lamp. As has been previously stated, a Nernst glower at normal temperatures is practically a non-conductor of electric current, and consequently to put a lamp in operation it is necessary first to heat the glower to a certain temperature. This is accomplished by means of a heater, which will be described later in detail. When a lamp circuit is closed, the current from the line first passes through the heater circuit, which circuit is automatically cut out when the glower becomes sufficiently conductive. Referring to Fig. 7, it will be seen that, assuming the glower to be non-conductive, all of the current will first pass through the heater. As the glower becomes conductive a current begins to flow through its circuit, this circuit also including an iron "ballast" or resistance wire, which will be referred to later, and a cut-out coil; when the current reaches a predetermined amount, the cut-out coil operates and the heater is cut out of circuit. Thenceforth the current passes through the glower, ballast and cut-out coil, to line. In Fig. 8 the organization of the several parts in an actual lamp is shown.

This brings us to the consideration of the second very interesting feature of the Nernst lamp—the ballast coil, due to Mr. Henry Noel Potter. As in the case of ordinary conductors, the resistance of a glower when heated varies with its temperature, and it happens that at the temperature most desirable in the working of the glower, the decrease of resistance with increase of current is quite rapid. As a consequence, without any controlling device in circuit, at this particular point a relatively small increase of current might so reduce the resistance as to quickly result in a flow sufficient to burn out the glower. Iron wire possesses the opposite property of increasing in resistance as the temperature increases, and it very fortunately happens that at a certain critical temperature this increase of resistance becomes very considerable for relatively small increases of temperature. If then an iron wire is placed in the circuit

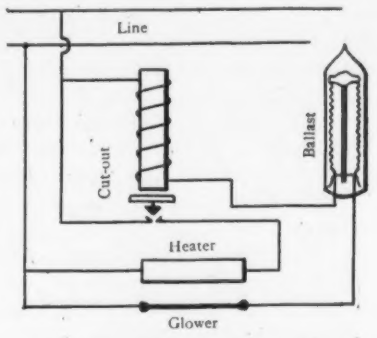


FIG. 7.—NERNST LAMP CIRCUIT.

of the glower, of a size selected so that its temperature during the normal working of the lamp is at or near the critical point, an increase of current will cause its resistance to increase in about the same proportion as that of the glower decreases. This is illustrated in Fig. 9, which gives curves of the variation of resistance with increase of temperature of a glower, and ballast, respectively (the latter to a larger scale), and a resultant curve which represents the variation of the current passing through the lamp with increase or decrease of voltage. The flatness of the glower curve indicates that a very slight change of voltage would produce a very great change in the current, while the effect of the ballast wire is to make the resultant curve almost vertical in its working part; thus a very considerable change in voltage will necessarily give rise to but a small change in current.

As constructed, the ballast is kept within remarkably small compass, the dimensions of a tube for a three-glower lamp, for example, being 11-16 in. in diameter and 2 3-16 in. long. The diameter of the wire varies from .001 in. in the smallest ballast to .004 in. in the largest. The length of the wire before being given a helical twist, is from 4 in. to 12 in. and the resistance from 25 to 80 ohms. The drop in the ballast is about 10 per cent. of the total drop between the lamp terminals. The wire is supported on a nickel standard having a cross arm to support the wire, which is threaded through porcelain insulators fused on the standard with glass. The bulb is finally exhausted and then refilled to about atmospheric pressure with hydrogen obtained electrolytically from an alkali solution.

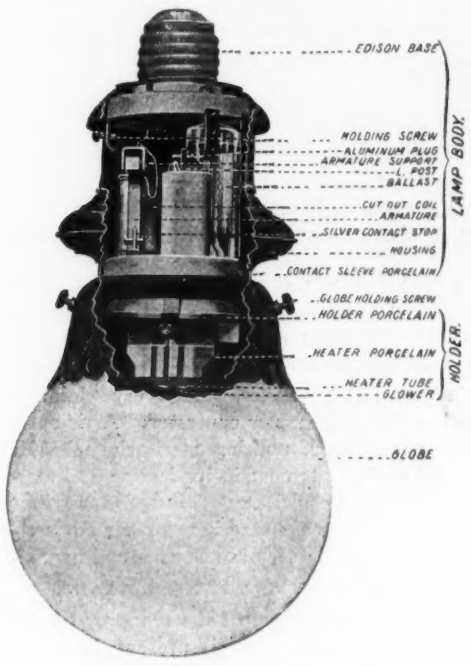


FIG. 8.—ONE-GLOWER NERNST LAMP.

The heating resistances are of platinum wire coiled about porcelain, then covered with a porcelain paste having the same coefficient of expanison as the wire, and baked. Owing to the necessity of having the porcelain uniform in quality and properties, the raw materials are worked into the finished product at the factory—not

only for the heating resistances but also for the mountings in the lamp frame. In the case of the smallest lamp, after baking the covering cement, the rod carrying the resistance is heated to a red glow and wound on a mandrel to a spiral form, the heat being applied as the winding proceeds. Naturally this is a delicate operation, but the arrangement for the purpose has been so carefully worked out that the operation is carried on by boys.

A problem of no small magnitude was involved in realizing a cut-out absolutely reliable in its action yet miniature in size, capable of controlling a current rising to several amperes in value and of remaining continuously in circuit with the lighting current. As perfected the cut-out, which breaks the circuit at two points, weighs for a three-glower lamp but 3¼ ounces and occupies a space of 2 3/16 in. x 1⅞ in. x 13/16 in. The contacts are of silver. The cut-out coil after winding is impregnated with a mineral compound which allows the insulation to stand a red heat if necessary, and is finally covered with asbestos sheet. The drop in the coil is about 1 per cent. of the total drop between lamp terminals. The number of turns in a coil are so fixed that the heater circuit is cut in when four glowers of a six-glower lamp are burned out, or two glowers of a three-glower lamp, or one glower of a two-glower lamp. Fig.

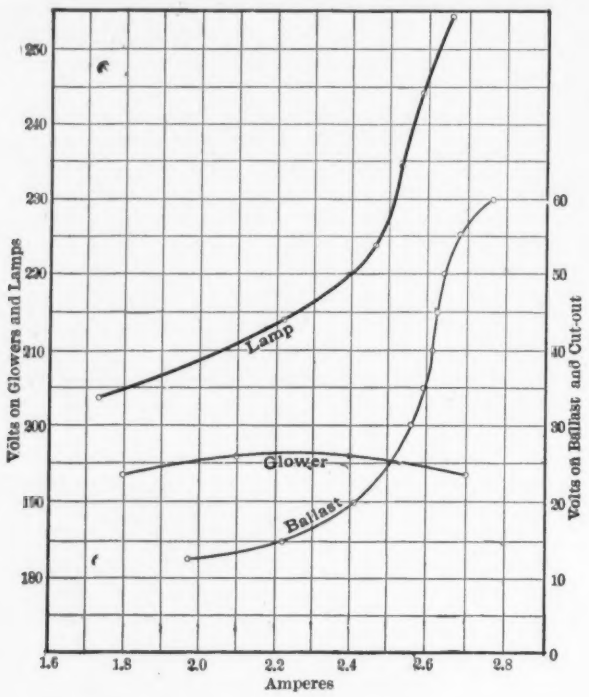


FIG. 9.—NERNST LAMP CURVES.

11 shows in outline a cut-out. As will be seen, the construction is very simple, the contact being maintained through the action of gravity; when the contact is broken the armature moves into a position with respect to the magnet poles which ensures a strong magnetic lock.

Entering a field that in late years has become strangely conservative, the Nernst light encountered as a late-comer conditions that its rivals in possession had escaped in the earlier days. Moreover, these latter have presented a solid front to what appears to have been regarded as an interloper, and every claim made for the Nernst lamp has been vigorously contested. As is apt to be the case in commercial competition, nothing meritorious has been conceded to the rival, and every statement in its favor met by a counter-statement showing instead a deficiency. What follows involves some of the controverted points, which are here presented in the light of the most reliable information which has been found available.

EFFICIENCY OF THE NERNST LAMP.

When we come to the subject of the economy of the Nernst lamp quite an array of diverse opinion is presented. Drude, the distinguished German physicist, credits the Nernst glower with an absolute luminous efficiency of 12 per cent., the corresponding efficiency of the incandescent lamp filament being variously stated by authorities at from 2.5 per cent. to 6.5 per cent.; on the other hand, the claim has been made by an incandescent lamp interest that the efficiency of the Nernst lamp in commercial service is practically the same as that of the ordinary incandescent lamp. If, however, we accept Tumlirz's constant of 5.2 for the number of candles per watt for a luminous efficiency of 100 per cent., a 3.1-watt incandescent lamp has a luminous efficienty of 6.5 per cent. and a Nernst glower of 12 per cent. luminous efficiency corresponds to a consumption of 1.62 watts per cp.

When one refers to the candle power experiments that have been

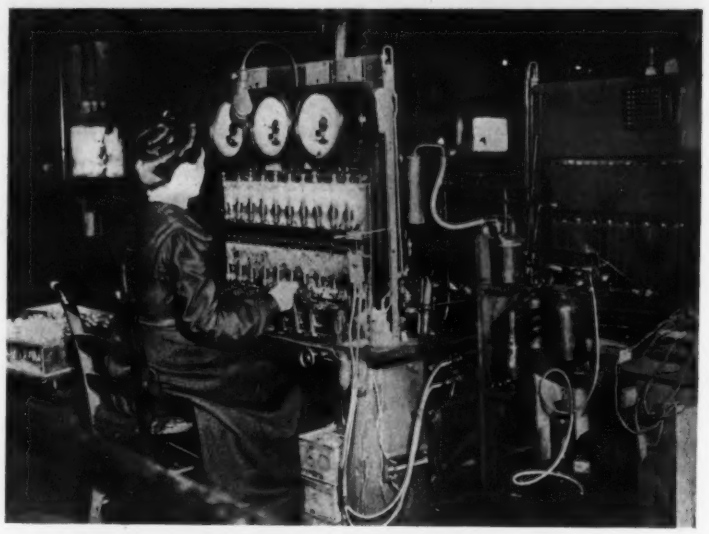


FIG. 10.—TESTING BALLASTS.

made on the commercial Nernst lamp, the results are apt to be so contingent on the experimenter's interpretation of what constitutes a candle power—whether it is to be considered in a spherical, hemispherical or some other significance—that the data are of little value for comparative purposes. It happens, however, that the Photometric Committee of the National Electrical Light Association has reported on measurements of the Nernst lamp in such a form that a comparison can be made between the performance of this lamp and that of arc lamps tested by the same committee and presumably according to the same methods. According to this report, the watts per hemispherical candle power consumed by a six-glower lamp were 1.88 per cp. with clear globe as compared with the following enclosed arcs with opal inner globes and clear outer globes: Direct-current series, 1.3 watts; direct-current multiple, 2.25 watts; alternating-current series, 1.19 watts; alternating-current multiple, 2.53 watts. With an opaque globe the consumption of the Nernst lamp was found to be 2.10 watts per cp.

Since the competition is with the multiple arc lamp, and since for interior lighting, hemispherical candle power can be accepted as a proper criterion, it will be seen that according to these tests the Nerst six-glower lamp is notably more efficient on the above basis than either the direct-current or alternating-current type of multiple

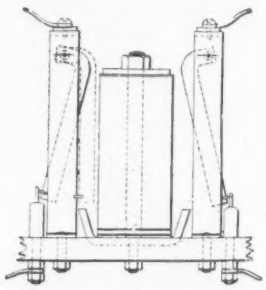


FIG. 11.—NERNST LAMP CUT-OUT.

enclosed arc lamp; and on the basis of either of the figures above given, it is still more notably efficient than the most efficient type of incandescent lamp used on commercial circuits, namely, the 3.1-watt lamp.

The lack of agreement as to what shall constitute a measure for practical illuminants is becoming daily more unsatisfactory and as a practical problem is pressing for solution—not only on account of the occasion which the present condition offers for all manner of claims and counterclaims on the part of those interested commercially in illuminants, but also because the public has a right to, and should be given in this as it has in other branches of business, some definite standard within its means of comprehension by which to

gauge what it purchases. And since the user of electric lighting current only wants that commodity—if we dare to term it such—for the illumination which it produces, the measurement of illumination where it is actually needed is what, in this connection, appears to be the desideratum. This is the view of the Nernst Lamp Company, and Mr. Alexander J. Wurts, chief engineer of the company, has proposed the following method of comparing the effect of illuminating powers of artificial sources of light:

The arrangement to comprise two rooms standardized with reference to size, color and furnishings, some convenient point of view being provided from which the illumination of both rooms may be readily compared. The primary room to be illuminated with incandescent lamps, say of 8 cp., arranged to the best possible advantage for the most effective lighting of the space; the secondary room to be lighted by the lamps to be compared, arranged also for the most effective illumination. An equally effective illumination in each room is then secured by switching on or off lamps in the primary room. The energy supplied to each of the two rooms being measured when adjustment is secured, these data will then represent comparatively the efficiency of the sources of illumination compared. It is stated that accuracy within 5 per cent. is obtainable with this method. That such a method would appeal to the lay user of artificial light may be taken for granted, though it would perhaps not satisfy the physicist any more than a town clock would satisfy an astronomer. None will deny that what is sadly needed is a yard stick for illumination; what is now usually offered may be likened to an offer to a perspective user of measure of length—who would be satisfied with a 5-cent graduated stick—of a certified standard necessitating a microscope to locate the lines thereon fixing the desired length.

But it should be added that the superior economy of the Nernst lamp as registered at the meter is only a part of the claims it can put forth for recognition. The human eye does not take cognizance alone of meter efficiency, but applies criteria of its own. Owing to the approach of the Nernst light to the quality of daylight, the eye is better accommodated to illumination from this source, with a result that it will distinguish objects much better with the same measured illumination than in the case of a source not possessing this quality. To put an extreme illustration, one can easily imagine that a more satisfactory aspect of, say, a room would be obtained with the light of a single candle than with that from a 50-cp. source giving forth blood-red rays. That the beautiful quality of the Nernst light would make it a factor in the lighting field were its cost even much larger than that of its competitors less favored in this respect, is evident when we look back and note the course of the various modern illuminants—the progression from the candle to oil, from the latter to gas and finally to the incandescent lamp—in each case the quality of light dispossessing a cheaper source.

REGULATION.

One of the charges which has been made against the Nernst lamp is that it requires a closer regulation of circuit than the incandescent lamp. If this were qualified by adding that the incandescent lamp superior in this respect is a 4-watt lamp, the charge might perhaps be maintained, but in that case it would also hold good as against the 3.1-watt incandescent lamp. In point of fact, it is claimed for the Nernst lamp that a continuous five per cent. overload will not appreciably shorten the life of the glowers, whereas, on the other hand, accepted curves of incandescent lamp performance show a decrease in life of 60 per cent. under the same condition. At the present day the matter of proper regulation of circuit voltage is beginning to attract the attention which its importance demands, and the Nernst lamp has not been found wanting where this attention has been given; and where it is lacking the deficiency is equally fatal to the high-efficiency incandescent lamp. If improvements made in the electrical field during the past fifteen years had been subjected to judgment on the basis of their fitness with respect to the practice of the poorest central station, many of the most valuable advances of the period would be yet awaiting recognition. One of the benefits which the Nernst lamp will confer on the central station industry will be in strengthening further the present movement toward proper circuit regulation, in which benefit it will itself participate as only one factor among many making toward better central station financial returns.

MAINTENANCE.

Unlike the incandescent lamp, the frame and connections of the Nernst lamp form a permanent structure having an indefinite life, but its perishable parts have from time to time to be renewed. Of these the ballast has a life so long, averaging 25,000 hours, that in an organization for maintenance it plays little part. The heater has also a very considerable life, the period averaging about 8 months in ordinary use. The glower, however, like the incandescent lamp filament, has a practically definite term of use, at the end of which it would be advisable to replace the glowers whether burnt out or not. 800 hours are given as the guaranteed life on 60 cycles.

Two systems of maintenance for the Nernst lamp have been employed. In the one, all the installations within a certain radius are maintained for a fixed sum per month from a central maintenance bureau, which may be directly in control either of the Nernst Lamp Company or its central station customer on whose circuits the lamps are operating. This department of the lighting company is analogous to the meter department which is now becoming an auxiliary to all well-managed plants. Such an organization involves the services of an inexpensive class of help, consisting of an inspector who alone or with one or more assistants in the case of the larger plants, operates the maintenance system, visiting all installations periodically; for example, commercial installations may be visited weekly, and residential installations once per month, the user being instructed how to act in contingencies which may arise during the absence of the inspector. A complete stock of Nernst lamp parts is carried in the repair department. The work to be done here is so simple, owing to the careful provision made in the design of lamp details for easy renewal, that a boy or girl can in a short time acquire the necessary skill.

The second system is especially applicable to the larger installations and those in isolated localities. In these cases, the maintenance work may frequently be entirely taken care of by the building janitor or electrician, who has previously received some instruction and training, either at the company's works or from an expert repairman. Suitable quarters would be provided in the building in which a limited stock of repair parts and facilities for renewal work would be available.

The total cost of maintenance under these conditions will be comparatively low, provided the maintenance work is executed in a systematic manner; a certain portion of the day being given to inspection, with a complete inspection of all lamps installed, the repairing of defective holders being afterwards done in the repair room. We are informed that the results obtained by the company from a number of prominent installations go to show that the cost of maintenance of the smaller lamps approximates that necessary for incandescent lamps, and the cost for the multiple glower lamp is practically the same as that for standard enclosed arc lamps.

Electric Lighting Chicanery.

The following item was printed in the New York *Evening Post* in a recent issue. It is not without its humorous side: "Comparatively few persons know why an electric lighting company is so exceedingly kind to its customers as to give them new incandescent lamps without charge in exchange for those which have burned out. The employees are always so polite, almost anxious to make the exchange. Any one can find out the reason by burning new, high-priced lamps for a month, and the next month the lamps the company gives in return for old ones. His bill will show that the reason, from the company's point of view, is an excellent one. The lamps supplied by the companies are invariably 'renewed' lamps; that is to say, old lamps made new by a delicate but not expensive process; and 'renewed' lamps burn more current—much more. The millennium is not yet here." There is deep villainy for you. As a matter of fact, we should be glad to get "renewed" lamps exclusively; at least no objection would be raised. In view of the fact that they have been in use, the occluded gas in the platinum, etc., have been pretty thoroughly disposed of, and such lamps are, therefore, quite likely to beat new ones all hollow for economic efficiency. But their use is vastly exaggerated. One local company we could mention, out of over 1,500,000 lamps bought had only 6,000 "renewed," and that is probably about the general ratio.

Recent Electrochemical Developments.

PRODUCTION OF SODIUM HYDROXIDE.

Two patents granted on May 10 to Mr. Blackmore, of Mt. Vernon, N. Y., relate to the electrolytic production of sodium hydroxide. The process described by him in one of the patents is in its essential points similar to the well-known Castner-Kellner mercury cathode process, which is in actual operation on a large scale. Various modifications have been suggested for this process, relating especially to the method by which the cathodically formed sodium amalgam is removed from the electrolyzing cell for the production of sodium hydroxide in another cell. For instance, Bell proposes to use for this purpose the atmospheric pressure of the gases developed in the cell; his process has been tried on a large experimental scale by the Pennsylvania Salt Manufacturing Company at Wyandotte, Mich., during the last three years, but it does not seem to have yet been reduced to industrial practice. Blackmore in his present patent produces the movement of the mercury and amalgam through the various vessels in his apparatus solely by the differences of level of the various bodies of mercury and amalgam. These differences are maintained by a suitable adjustment of a float-fed and a float-controlled outlet, and of the height of the connecting pipes. The mercury, after the sodium has been removed from it, is pumped back into the first vessel which supplies mercury to the cathode in the electrolyzing cell.

The second patent of Mr. Blackmore refers to the production of sodium hydroxide from the cathodically formed sodium amalgam or sodium lead alloy (in the latter case a molten lead cathode being used as in the Acker process). In what follows we assume a molten lead cathode. Mr. Blackmore's apparatus consists essentially of an electrolyzing vessel with a diaphragm dividing it into two compartments. The anode compartment is in the center and contains fused sodium chloride on top of a floating diaphragm, which consists of magnetite broken into small fragments. This diaphragm floats on the molten lead cathode which extends into the outer vessel. The specific gravity of the diaphragm is greater than that of the molten electrolyte in the anode compartment, and smaller than that of the molten lead cathode. The lead sodium alloy produced by electrolysis, being lighter than lead, continually arises to the surface of the molten lead, and may be drawn off there. The author, however, considers it preferable to change it into hydroxide, and has found the following method suitable. Molten sodium hydrate is injected in a plurality of fine streams into the molten lead-sodium alloy, and is reduced by the sodium to sodium oxide with evolution of hydrogen which passes off. The sodium oxide arises and flows on the surface of the cathode and, remaining in a molten condition, it is continuously drawn off. To facilitate the oxidation of the sodium, a layer of loose granular conducting material, like iron, magnetite of ferro-silicon, is arranged at the surface of the cathode. This loose material serves to distribute the streams of sodium hydrate and bring them in thorough and intimate contact with the sodium in the alloy. "The oxidizing reaction is facilitated by the innumerable local couples due to the contact of the sodium and the relatively negative particles of iron, etc."

BATTERY INVENTION.

A patent granted to Mr. C. J. Reed, of Philadelphia, refers to the construction of a plate suitable for Planté formation. The plate consists of numerous corrugated panels with intervening strengthening ribs and side ribs, the exposed surfaces of the panels being corrugated so as to have a large surface. The plate is made by passing molten lead between corrugated rolls and subsequently subjecting the plate to lateral edgewise compression in order to reduce the grooves to the smallest practicable width.

A patent granted to Messrs. R. Fortun and E. Semprun, of Madrid, Spain, relates to a storage battery, the feature of which is the active material of the positive electrode. This active material is produced by electrolysis, between lead electrodes, of a saturated solution of oxide of lead in a lixivation of potassium hydroxide, rock candy and neutral potassium tartrate. By this action a brown substance is deposited on the anode for which the claim is made that 100 grams of this substance are capable of fixing 369 grams of oxygen. This active substance is used for the positive pole electrode in an accumulator with a solution of 17 parts of lead nitrate in 100 parts of water, acidulated with pure nitric acid until the solution registers 20° Baume.

A patent granted to Messrs. J. Noble and E. L. Anderson, of St Louis, represents a new attempt at utilizing the heat of oxidation of carbon for the production of electrical energy. The cell consists of an aluminum plate and a carbon plate with an electrolyte of nitric acid, heated to 150° F. The cell is claimed to have an e.m.f. of 1.5 volts, the current flowing in the solution from the aluminum to the carbon. The following actions are assumed to take place in the cell. Oxygen is evolved at the aluminum anode without attacking it, while at the cathode the nitric acid is reduced to nitrogen peroxide, which oxidizes the carbon cathode, thereby forming carbonic acid gas and nitrogen oxide gas. The nitrogen oxide gas unites with the oxygen evolved at the anode and forms nitrogen peroxide gas, which passes into a condenser filled with a mass of moist carbon or coke, and is therein condensed to nitric acid, returning then to the battery. The claims of the inventors that without destruction of the aluminum plate electrical energy is produced at the expense of the change of the carbon plate to carbonic acid gas and at the expense of heat supplied from the cathode.

New Telephone Patents.

If the general activity in any field of industry may be measured by the activity of its inventors, then truly must telephony be in a prosperous state, for we have at hand this week for consideration an extraordinary number of telephone patents. These treat of a great variety of subjects, as might be expected, but for convenience they will be grouped together under topical headings in so far as possible. The first group will include patents bearing on central office apparatus.

CENTRAL OFFICE APPARATUS.

The heat coil or sneak current protector forms the subject of three patents. These all apply the same principle, viz.: the shortness of fusible metals when slightly heated. The application of the principle is, however, made in two different ways. In Fig. 1 is shown sectional views of all three new coils.

At the right is a heat coil patented by M. Setter, of Chicago. As will be noted, on one end there is a hinged plate to which a stud

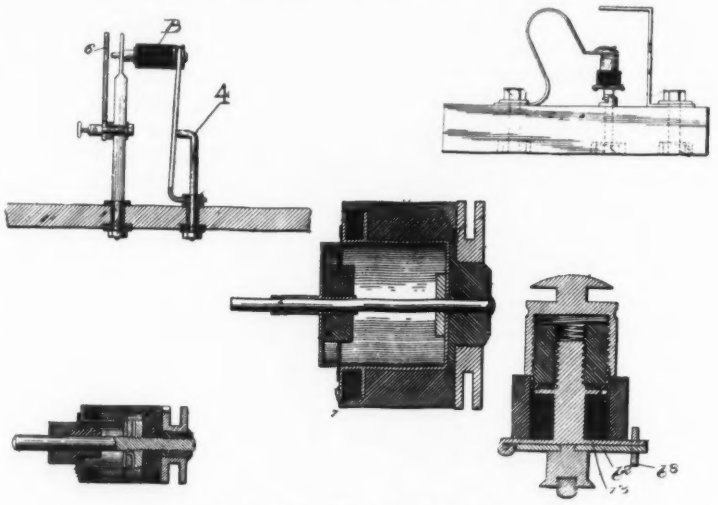


FIG. 1.—TELEPHONE CUT-OUTS.

is attached. Normally, a ring of fusible metal encircling projections from the pieces b^2 and b^3 holds them together. In this condition the coil is adapted to be mounted in a spring holder which strives to pull the ends apart. When an abnormal current passes in the circuit, which is led through the heat coil, from one terminal button to the other, the heat generated so affects the solder ring, b^8, that its tensile strength is impaired and it breaks. The hinge at once opens, giving, as it does so, an inclination to the stud, b^1, such as to cause it to escape from its holder and thereby breaking the circuit, which at once becomes grounded against the stop for the spring terminal. The other two heat coils cause a shearing of solder under exactly similar circumstances, to effect an operation of the switching members. One of these is shown at the middle of Fig. 1, while the other, together with a mounting suitable for either, is shown at the left. In both the heating coil proper is in annular form, surrounding a cup within which a plunger may be forced. The plunger is normally blocked, however, by a washer of

solder, which lies between its bottom and the mouth of the cup. The tendency of the mounting springs is to cause the plunger to clamp the washer, as a plate between a punch and die. With slight heating of the coil shearing takes place, the circuit opening at the point 4 and grounding at the point 6. The chief point of distinction between the two coils of this type lies in the substitution of an insulating shearing plug in one, that shown on the left, for the metal shearing plug of the other. Of these coils Mr. Setter is the inventor of one and H. P. Claussen the inventor of the other. Both have assigned their right to Messrs. P. C. Burns and J. G. Shimsen.

A. M. Knudsen, of Chicago, has produced a combined jack and drop for switchboards in which the drop shutter is mechanically restored by the insertion of a plug into the jack in answering the call. The restoring is accomplished by a pivoted member, one end of which hangs in the path of the plug in a manner to be rotated by the insertion of the latter, while the other end engages an extension of the drop shutter so as to restore the shutter as the rotation takes place.

A second mechanically restoring annunciator is that patented by Albert Corliss, of Chicago. In this the target or shutter revolves on a pivot, the signal being displayed before a window in the casing which holds the annunciator and jack in proper relation. The restoring is accomplished by a spring member which engages a stop on the rotating shutter. This spring is elevated by the entering plug, and its end engaging the stop causes the shutter to rotate into normal position, where it becomes locked pending the arrival of another call. The American Electric Telephone Company has been assigned this latter patent.

SWITCHBOARD CIRCUITS.

Switchboard circuits are represented by three patents. One of these shows a rather simple common battery system, while the other two relate to the divided multiple switchboard. The common battery system patent has been granted to Mr. D. W. C. Tanner, of Chicago. The circuit is shown in Fig. 2. For the purposes of explanation it will be assumed that a call is started from the left-hand station. The removal of the receiver from the hook closes the circuit through relay *a*, which, responding, energizes the line lamp and busy test for the calling subscriber. The operator responds in the usual way with plug *t*, the answering plug of the connecting cords shown. This extinguishes the lamp, as the battery, b^1, opposes battery *b* and reduces the potential around the lamp sufficiently to do so, this reduction of potential, of course, being traceable to the series resistance, *c*. It will be noted that no supervisory light is shown. This is because the line lamp of the calling line serves this purpose; to this end it is arranged so that once extinguished by the response of the operator, it will not relight until both subscribers have hung up.

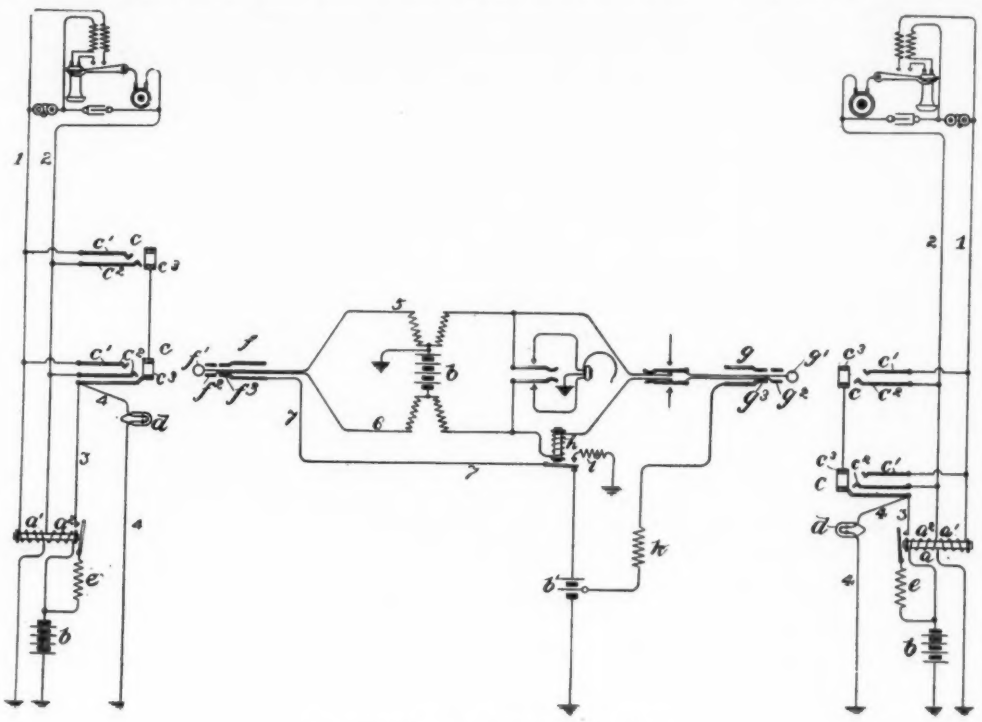


FIG. 2.—TANNER SWITCHBOARD SIGNAL.

Suppose, now, the operator to proceed with the connection by plugging into the desired line. This will put a busy test on this line from the tap, *k*, but will not cause the called line's lamp to glow, as insufficient potential is provided. Now, the called subscriber answers, energizing his relay, *a*. Still his lamp fails to glow, as tap *k* forms a shunt about it. When the subscriber answered another change occurred, as relay *h* was energized and connected the shunt, *l*, around the calling subscriber's lamp, *d*, instead of the battery, b^1. Now it is evident that *d* will only glow when both subscribers have hung up, for if the calling subscriber alone does this no battery connection exists in the lamp circuit; while if the called subscriber hangs up alone there is a return to the battery shunt, b^1. If both hang up, battery b^1 alone is effective and this lights the signal.

The circuits for divided multiple boards are both the work of E. H. Smythe, of Freeport, Ill., and show two alternative methods of accomplishing his desired result. With the divided multiple switchboard of the type in question, each line is provided with one answering jack and line signal for each division of the multiple, and in signalling he must operate that one of his signals which is associated with the division corresponding to the desired subscriber's number. At times it is found that a subscriber will call in error, and noting his mistake remakes the call to the proper division. Under such circumstances confusion would, of course, arise unless some means of preventing the co-existence of two signals from the same line. Mr. Smythe overcomes the difficulty by making the signal relays, which cause the display of the signals, interconnecting in such a manner that the one last energized disconnects or de-energizes the other. Therefore, the corrected signal at once and automatically extinguishes that made in error. Both Mr. Smythe's and Mr. Tanner's patents have been assigned to the Western Electric Company.

SUBSCRIBER'S STATION APPARATUS.

Undoubtedly quite frequently telephone users are disturbed for fear that what they say into the transmitter may be overheard by those in the immediate neighborhood. For some the sound-proof booth serves every purpose, but this because of the inconvenience of entering it and the space it occupies is not always satisfactory. To overcome this difficulty a transmitter hood has been patented. This is a metallic box adapted to be fastened upon the transmitter, and of such size and shape that when the face is closely pressed against it the lips will be in proximity to the transmitter mouthpiece. The box is of small size, the edge of the aperture coming in contact with the chin, cheeks and upper lips only. The edge is provided with a rubber cushion and is shaped to fit the face. As it is necessary to keep secret but a portion of one's conversations, the sides of the box, four in number, are made folding and are so controlled by a spring that they may be folded back. R. D. Fannon, of Chicago, is the patentee of this apparatus.

A new telephone set has been invented by Messrs. S. C. Houghton, of San Francisco, Cal., and F. M. Potter, of Syracuse, N. Y. Vertical slide bars support an adjustable frame upon which both transmitter and receiver are carried. The receiver is upon the end of an arm consisting of two bars, which are insulated from each other and serve as the conductors to the receiver coil. The receiver is held in a position to the side of and in front of the transmitter ready for use. A slight pressure upon it in a horizontal direction serves to throw the switching device, while a semi-automatic electromagnetic switch enables one to hold the line conveniently while leaving the instrument.

For use in damp places, or where water is likely to be dashed about, as on shipboard, a water-proof subscriber's set is advisable. Such is one invented by Alfred Graham, of London, England, which has been recently patented. The casing is of metal and all apparatus is contained therein, entirely protected except when actually in use.

Mr. A. W. Hill has brought out a novel transmitter in which one block of carbon serves as the body of the casing and the stationary electrode. A sectional view of this transmitter is shown in Fig. 3, which indicates how the diaphragm, mounted between rubber pads, is clamped to the carbon block by the face plate. Within a central and deeper recess in the carbon block the microphonic button is built up. The recess is lined with an insulating tubular bushing, which contains the granular carbon. The bottom of the recess forms the rear electrode, while the front electrode attached to a metal backing slides within the bushing, the joint being jacked by a felt ring.

The two remaining patents to be included under this head describe

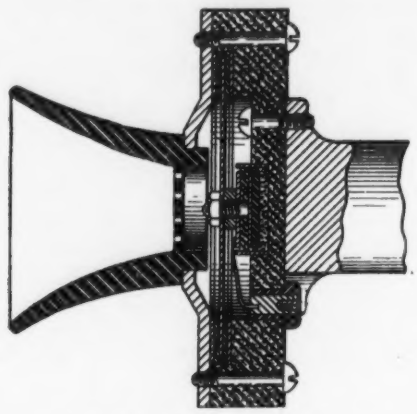


FIG. 3.—HILL TRANSMITTER.

respectively a receiver and a ringing generator. The novelty in the receiver lies in the method of mounting the magnet within the casing. The casing is in three parts, a joint being made in the body near the bell. The magnetic system carries a collar secured to it near the coils, and this collar forms the coupling for uniting the two parts of the body of the casing. The distance which the collar is screwed into the bell piece of the casing determines the air space between the diaphragm and poles. The tail piece is then screwed up like a lock nut securing the whole in adjustment. W. C. Runge has been granted the patent for this.

MISCELLANEOUS.

While the effects of electrostatic capacity have been brought well under control by the Pupin system of loading conductors, all other steps towards ameliorating its detrimental qualities are interesting. Mr. J. S. Richmond, of New York, aims to do this in his transmission system described in two recent patents. Mr. Richmond argues that with a metallic circuit in a cable of conducting material, i. e., a conducting shell, all capacity between the individual conductors and the shell will be obviated if the potential of the shell be kept a true mean between the sum of the potentials existing on the conductors at all points. He accomplishes this by finding the inductive neutral of each end of the line and grounding this. Such a process, of course, renders it necessary to use double-wound apparatus of that type designated as "split" wound, but this would not weigh against the system if the gain in transmission is found to be material. Any one who has tried to solder a wire to a gas or water pipe, or to make a secure joint by wrapping for the purpose of obtaining a ground connection, appreciates what a boon was the introduction of sheet-metal ground clamps. An improved ground clamp of this type readily adjustable to different sized pipes has been patented by Messrs. F. P. Fuller and J. J. Walsh, of Yonkers. In this clamp the actual connection seems to be made chiefly between the clamping screws and the pipe, the metal band serving merely to hold the screw ends against the pipe.

Many already know that method of handling distributing wires wherein they are carried in rings supported by a messenger strand. Such a scheme is most successful. However, it has been found advisable to hold the rings at definite distances apart by an auxiliary fastening, such as a wire or yarn running parallel with the messenger and independent thereof. F. C. Locke has obtained a patent for a method of fastening the rings based on these principles. A train telephone system for communicating to and from and between moving trains, a step-by-step selective system, and a special arrangement of telephone incandescent lamp bulbs for exhaustion, comprise the subjects of the remaining three patents. These have been invented respectively by Messrs. C. G. Otwell and S. H. Melvin, Mr. C. A. Anderson and Mr. A. D. Whipple. For information concerning them the reader is referred to the patents as the subject matter does not seem of sufficiently general interest to warrant discussion here.

CURRENT NEWS AND NOTES.

FEMALE STREET CAR CONDUCTORS.—A Springfield, Ohio, despatch dated May 17, says: After six years of experiments the officers of the street railroad company at Chillicothe have decided that the women conductors must go. The women were satisfactory, except that they were not strong enough for switching work. Switching at home would be more in their line, it would seem.

CELEBRATING TELEGRAPH ANNIVERSARY.—The Postal Telegraph Cable Company is to celebrate this week in New York the tenth anniversary of the opening of its central office building and the sixtieth anniversary of the first telegraph message. The exercises will take the form of a conference of the leading officials from all over the country, with a banquet on May 24 at the Hardware Club. The previous night there will be a large theatre party at Wallack's to see "The County Chairman." Mr. C. P. Bruch is organizing the functions.

DETECTING DIAMOND IN STOMACH.—A news note from Texas states that a thief there swallowed a diamond worth $250, and then was arrested and taken to jail. Investigation by means of the X-ray revealed that it had "become imbedded in the wall" of the man's stomach. The owner of the diamond offered to pay for a surgical operation, and it was performed with entire success, so that the owner has recovered his diamond and the thief was still alive at last accounts, with good prospects of recovery. At least, so the story goes in the dispatches.

COMMERCIAL AUTOMOBILE TESTS.—As a result of the service tests of motor wagons made under the auspices of the Automobile Club of America, gold and bronze medals have been awarded to the electric delivery wagons of the Pope Motor Car Company to carry from 1,000 to 2,000 pounds; a gold medal to the electric truck of the Electric Vehicle Company, to carry between 4,000 and 5,000 pounds, and a gold medal to the gasoline-electric truck of the Fischer Motor Vehicle Company, to carry from 8,000 to 10,000 pounds. The committee will presently issue a full report on the subject of the tests.

WIRELESS TELEGRAPHY AT THE FRONT.—Capt. James, the efficient correspondent of the New York and London *Times* at the seat of war, has been silent for some time lately. He has resumed his work, but in his wireless dispatches admits that Japan had temporarily warned him off the fighting zone, just as Russia had done, although in a slightly more polite way. "My position was difficult in the extreme. I was threatened with capital punishment by one belligerent and warned off the high seas and neutral waters by the other. Only two courses remained open: Either to submit to the Japanese wishes or claim the right of a neutral flag on the high seas, in which case the only control of either belligerent would be *force majeure*. In deference to former courtesies on the part of the Japanese, I took the former course."

SELECTIVE SIGNALLING BY RESONANCE.—Dr. M. I. Pupin is to lecture before the New York Electrical Society on May 25 at the Havemeyer Building, Columbia University, on "Selective Signalling by Electrical Resonance." Dr. Pupin will explain the principles and the essential elements of this system of transmission. These elements are: The multifrequency alternator, the transmitter, the distributors, the resonators, and the rectifiers. At the special request of the U. S. Patent Office Commissioner, Dr. Pupin has prepared an exhibit for the pavilion of the U. S. Patent Office, at the St. Louis Exposition, illustrating by a complete model the transmission of telegraphic messages by alternating currents of various frequencies, the receiving and the transmitting apparatus being electrically tuned to the frequencies which they are intended to receive and transmit. This exhibit will be shown at the lecture. The lecturer will discuss at some length the application of electrical resonances on which the development of wireless telegraphy may so largely depend.

RADIUM FOOD PRESERVATIVES.—At a recent meeting in New York City of the Food Standard Committee, L. Lieber, of H. Lieber & Co., New York chemists, spoke in defense of chemicals used in coloring foods. He said that they commonly preserve the food while exposed to light and cease to act when out of the light, so that when the food is eaten there is no interference with digestion. In his opinion these substances are much superior to the so-called preservatives. Mr. Lieber also said that the time is coming when radioactivity will entirely supplant the chemicals now used for preservatives.

POOL ROOM TELEGRAPH SERVICE.—The following is part of a series of resolutions adopted by the Western Union Telegraph Company: "The Executive Committee hereby instructs the officers and employees of the company to withdraw immediately the service of racing news from any place or places that shall be designated as unlawful pool rooms by the Commissioner of Police of New York City or the District Attorney of New York County, accompanied by a request to make such withdrawal, and to furnish hereafter such racing news only to such applicants as shall give assurance that it is not to be used for pool room purposes." The company has since discontinued its race news service and the New York Telephone Company has promised to take out its telephones in pool rooms.

GOOD BUT NOT CHEAP.—Mr. Godfrey L. Cabot, writing from Boston, Mass., under recent date to the *American Gas Light Journal,* inquires: "Perhaps some of your readers can kindly tell us whether paraffine paper has ever been tried as a protection of pipes from electrolysis. It seems to me that, by neatly fitting paraffine paper around the pipe, and wrapping outside this a bandage of cloth, soaked in coal tar pitch or asphalt, a protection could be obtained against electrolysis under the conditions usual in our streets. Care could have to be taken that the inner layer was impervious, as asphalt itself is not a sufficiently good insulator to give the required protection. I hope that some one of your many readers will be able to answer this question. Six years ago I investigated the subject of electrolysis in many European countries and found that in many places the street railway companies were compelled by law to bond their rails in an efficient manner, and that this greatly diminished the difficulty; but we are not all protected in this way."

WIRELESS TELEGRAPHY AT SEA.—Mr. G. Marconi arrived in New York City from England last week on a trip to test some new apparatus. On the Cunarder *Campania* Mr. Marconi was accompanied by his assistant, G. S. Kemp, two special operators, two secretaries, and Mr. W. W. Bradfield, chief engineer. The inventor had a state room on the port side of the vessel, and in it he installed his key, the wires leading to the truck of the foremast. On leaving Liverpool the vessel was put into communication with the shore stations at Poldhu, Seaforth Sands and Crookhaven. During the voyage the vessel logged 3,158 knots. According to his statement on the subject, Mr. Marconi continued to send messages to the Poldhu station until he was 1,700 miles at sea. After the vessel had passed the 1,500-mile mark he sent messages to Cape Breton, cutting off Poldhu after 1,700 miles. Everything sent to the land stations was received, and the only mistake made was in the name of Gen. Sir H. C. Wilkinson, a passenger on the *Campania,* whose name at a distance of 1,600 miles was received "Wilson."

ELECTRIC SMELTING OF IRON.—Dr. Haanel, Dominion Superintendent of Mines, who recently went to Europe to investigate the methods in vogue in that part of the world, of electric separation of iron ore, has just received a consignment of samples of gray, white and mottled pig iron, all having been reduced from iron ore direct by the aid of an electric furnace. Samples of cast-iron castings are also exhibited as made from the molten metal taken from the electric furnace. These castings, from but once smelted metal, are stated to be in quality equal to any cast-iron castings produced. The grey pig iron is a superior grade of foundry iron. This grade pig can be also used for the purpose of conversion into steel by the acid process. Dr. Haanel is hopeful of the process being very useful in converting the immense iron ore beds of Canada into marketable metal. The process is particularly applicable to Canadian conditions, viz.: abundance of water power for electricity, incalculable quantities of ore and not sufficient coal near to make ordinary smelting pay. Dr. Haanel thinks that the process may revolutionize separating processes, as it can be applied to all classes of metals.

LETTERS TO THE EDITORS.

The Metric System.

To the Editors of Electrical World and Engineer:

SIRS:—In view of the fact that your issue of May 7 seems to criticise the tone of our circular letter eliciting the opinion of the members of our Association on the compulsory metric system bill, I would respectfully suggest as a means, and perhaps the only means, of representing that you yourself intend to be perfectly fair in your discussion of the matter, that you print for the benefit of your fair-minded readers the circular letter in question, a copy of which I enclose herewith.

NEW YORK. MARSHALL CUSHING,
Secretary, National Association of Manufacturers of the United States of America.

[We print below the circular letter referred to.—EDS.]

"There has been such a large increase (nearly 200 per cent.) in the membership of the Association since the vote upon the adoption of the metric system was taken a year and a half ago, that your Executive Committee has thought it best to repoll the Association on this important matter. You are, therefore, requested to signify your sentiments upon the enclosed ballot, and sign and return it at once to the General Office.

"Since the first ballot was taken the adverse vote then expressed has been concurred in by the following associations: The American Society of Mechanical Engineers, the Railway Master Mechanics' Association, the Master Car Builders' Association, the Furniture Association, the National Metal Trades Association. Similar action had already been taken by the Association of Machine Tool Builders, the Engine Builders' Association, the Society of Naval Architects and Marine Engineers, the Society of Heating and Ventilating Engineers and the Providence (R. I.) Society of Mechanical Engineers.

"The metric system bill was withdrawn from the last Congress by its friends because of the shortness of the session, but with the understanding that it is to be pressed again at the present session. This bill reads:

"'That on and after the first day of January, 1904, all the departments of the Government of the United States, in the transaction of all business requiring the use of weights and measures, excepting in completing the survey of public lands, shall employ and use only the weights and measures of the metric system; and on and after the first day of January, 1907, the weights and measures of the metric system shall be the legal weights and measures of the United States.'

"Please note that this ballot does not involve an opinion on the merits of the system. You are only asked to say if you want it adopted by law."

To the Editors of Electrical World and Engineer:

SIRS:—In an editorial in your issue of May 7 you say that in addition to the three engineering bodies named in the publication of the National Association of Manufacturers as favoring the metric bill, there are at least three more among the most prominent in the country that might have been included in the list, their pro-metric votes having been officially published. I deny this statement and challenge you to print the names of the bodies.

NEW YORK. ANTI-METRIC.

[The bodies referred to are the American Institute of Electrical Engineers, American Electrochemical Society and the Franklin Institute.—EDS.]

The Harmful Suppression of Inventions.

To the Editors of Electrical World and Engineer:

SIRS:—Your editorial of April 16 concerning the working of patents brings up a question of the greatest interest. It is important, however, to distinguish between the proper suppression of inventions and their harmful suppression. It is proper that the owner of expensive machines should acquire a patent covering cheaper machines for making the same product, and should suppress the invention for a limited term, rather than scrap all his expensive machinery at once. No serious harm is done to the progress of science and useful arts in the United States, since by the end of the term of the patent the manufacturer may be compelled by competition to adopt the simplified machinery. If he does not do so, others will. For this benefit

to the country the patent owner is entitled to the reward of a monopoly for a limited time either by suppression or by exclusive use.

The more harmful case is the suppression of inventions in the United States which are being worked in a foreign country. During the seventeen years of the monopoly, the foreign manufacturers are continually making practical improvements. The basic invention is not in practical use in this country, and such improvements are very unlikely. At the end of the seventeen years the original invention is public property here, but is not commercially valuable as compared with the improvements which are still controlled and used only in the foreign country. There is no incentive to the establishment of a new industry in this country under such conditions. This is exactly what has occurred in the case of dye-stuffs and other high-grade chemicals. The German manufacturers, the American market being secured by patents, have established a supremacy which it will be impossible to overcome for many years. The same thing is apt to occur in the establishing of any new industry in future. The constitutional provision upon which the patent laws are based applies to the promoting of the progress of science and useful arts in the United States. This use of a patent has only the effect to retard such progress.

This violation of the intention of the constitution should be a good ground for repealing a patent, but the difficulties in the way of repeal are so great that it is doubtful if it will ever be tried. It remains, therefore, for Congress to provide a suitable remedy, such as an alternative requirement of a bona fide working of the invention in the United States (accompanied, perhaps, by a prohibition of importation) or the granting of a license to others on reasonable terms. If this is not done there will be a number of industries developed by purely artificial means in other countries and never seeing the light of day in this country.

NEW YORK CITY. DOMINGO A. USINA.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Design of Electrical Machinery.—HUNT.—A paper read before the Liverpool Engineering Society. The author first discusses direct-current machines. Since commutation becomes more difficult the higher the voltage it is advisable that in order to reduce the number of designs as much as possible, at least for small machines up to say 100 hp, the armatures should be designed for 500 to 550 volts; it will then be quite easy to obtain excellent commutating qualities for all lower voltages. To determine the commutating qualities of a machine, the author thinks that it is only necessary to consider the armature ampere-turns per pole, and the length of the armature core, to arrive at a satisfactory basis for calculation. The e.m.f. induced in a short-circuited coil opposing commutation may then be said to be proportional to the armature ampere-turns per pole, the number of turns per commutator part, the speed of the machine in revolutions per minute and the length of the core. The author gives some numerical data on this subject, especially in connection with a special machine, the details of which are given. Concerning commutator losses he says that consulting engineers often specify a maximum value for the current density at the contacts of carbon brushes and commutator, irrespective of the voltage and speed at which the machine may be operated. This often results in the commutator losses being greater than need be. He points out that for any given peripheral speed at which a commutator may be running, there will be a certain current density at the contacts of the brushes which will give a minimum value of the commutator losses. To make these losses a minimum, the contact surface of the brushes should be so chosen that the loss due to friction is half that due to the C^2R loss at the contacts. He then discusses alternating-current machines and says that the value of the power factor and the overload capacity of a motor is almost entirely governed by the demagnetizing component of the rotor current. At no load this is practically nil, but as the torque is increased, it grows with it, slowly at first, until the load is reached at which the power factor of the machine has its highest value. After this load has been passed, the rotor magnetizing component increases more rapidly until, when the motor is developing its maximum torque, it attains the same value as the component of the rotor current with which it is in quadrature. This demagnetizing current depends upon three things: First, the coefficient of leakage of the stator winding; second, the coefficient leakage of the rotor winding; third, the ohmic resistance of the stator winding. Instead of using the coefficients of leakage, the author finds it simpler to work out the coefficient of mutual induction between stator and rotor windings and then to estimate the coefficients of self-induction of the stator and rotor windings. In order to show the effect of the demagnetizing component of the rotor current upon the performance of a motor, details are given of the tests of a 20-hp machine.—Lond. *Elec.*, April 29.

Regulation of Alternating-Current Motors.—A note on a method of Lahmeyer & Co. for the regulation of non-synchronous alternating or three-phase current electric motors, and rotary converters. It is proposed to regulate the speed by inserting choking coils into the rotor circuit, instead of wasteful resistances, and to regulate the choking effect by varying the reluctance of the magnetic path of the choking coil. This may be done by more or less saturating this magnetic path by a variable number of continuous-current ampere-turns. The amount of these may be regulated either by hand or by automatic means, so as to maintain a constant speed of the motor. A purely electric method of automatically regulating the speed is as follows: The choking coil, besides being wound with the leads from the rotor, is also wound with two auxiliary coils, which oppose one another. One is permanently fed by continuous current from a constant-pressure supply, while the other receives its current from a small continuous-current generator (or from the generator proper in the case of a motor-generator) driven by the motor. If, now, the motor exceeds its normal speed, the voltage of the auxiliary continuous-current generator driven by it will rise, and the magnetizing effect of the bobbin, which is permanently excited, will be opposed to a greater degree than before. The permeability of the magnetic circuit of the choking coil will increase in consequence, and the choking effect will become more pronounced—i. e., the motor speed will decrease, and, if the arrangement be properly adjusted, the speed will be brought back to its proper value. If the motor speed decreases, the reverse actions take place.—Lond. *Elec.*, April 29.

REFERENCES.

Equipotential Connections.—MÜLLER.—The conclusion of his article. He has found in practice that machines which, without the use of equipotential connections, offer great difficulties as to sparkless commutation, would work absolutely satisfactory as soon as such equipotential connections were introduced. He gives algebraical rules how to calculate and introduce these connections.—*Zeit. f. Elek.* (Vienna), April 24.

Output Coefficient.—PENSABENE.—A communication on the output coefficient of induction motors. He thinks that the only useful and suggestive formula is the old $D^2L\,R\,\phi$, which is not an empirical one. To determine the nature of the coefficient, ϕ, he gives its expression by an analytical explanation of the fundamental formulæ used in induction motor designs.—Lond. *Elec.*, April 29.

Tests of Direct-Current Machines.—SMITH.—A paper illustrated by diagrams giving a review of convenient tests of direct-current dynamos and motors.—Lond. *Elec. Rev.*, April 22, 29.

LIGHTS AND LIGHTING.

Mercury Arc Lamp.—PAWECK.—A description of a mercury arc lamp which seems to be mainly of historical interest since it is claimed to have been the first lamp of this type with an automatic starting device. The lamp is shown in Fig. 1. *a* is the tube in which the arc is formed, connections being made by the platinum wires, *c*, at the two terminals, *b*. This horizontal tube can be revolved around the vertical axis, *mm*, connection to the source of current being made by the method clearly indicated in the illustration. *h, i* and *d, g* are platinum wires dipping in mercury. When the circuit is closed, the current passes through the mercury in the middle part of the glass tube, *a*, but at the same time a small electromotor begins to

revolve the glass tube, *a*, and the mercury in it is then driven by the centrifugal force to the ends of the tube, *a*, and the arc is started. The operation is stated to be quiet and noiseless, the revolving arc giving the impression of a horizontal lighted disc. The speed of rotation appears to have been small. This lamp was built at a suggestion of Kellner, who has later used amalgams instead of pure mercury in order to improve the color of the light. For instance,

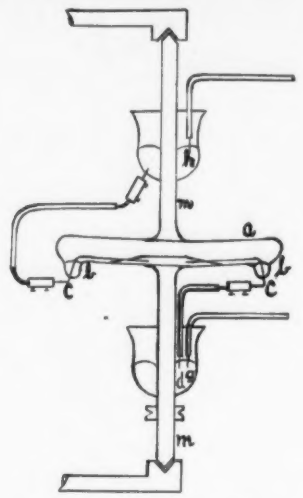


FIG. 1.—MERCURY ARC LAMP.

potassium amalgam gives a red tint. At the same time the use of an amalgam represents a new method of starting the lamp, since when the lamp is not lighted a thin film of amalgam is formed along the internal wall of the tube, which acts as a conducting bridge between the two electrodes, when the lamp is started. Afterwards this film is vaporized and the arc is formed. In another type of Kellner lamps, a plunger is used for starting. Credit is briefly given to the work of Hewitt.—*Zeit. f. Elektrochemie,* April 29.

Miner's Lamp.—A description of the Neu Catrice portable electric lamp for miners. The base of the lamp consists of a box of sheet lead containing two accumulator cells made of transparent celluloid or semi-plastic India rubber. Each cell contains one positive and two negative plates. The united elements constitute a battery of a mean voltage of 3.9, sufficient to supply, for 15 consecutive hours, a small incandescent lamp with a constant illuminating power of about one candle. In order to avoid the spilling of the liquid, the electrolyte of the accumulators is "fixed by a special process," in such a way that the lamp may be used without risk in any position whatever. The protecting globe is painted to one-half with a semi-translucent white varnish which acts as a reflector, while allowing a certain amount of light to be diffused backward. A lamp giving 1 cp for 15 hours weighs five pounds. It consumes 3.5 watts per candlepower. To recharge the lamps a charging table, consisting of 20 or 40 compartments is used, according as the available e.m.f. is 110 or 220 volts.—Lond. *Elec. Rev.,* April 22.

REFERENCE.

Three-Phase Arcs.—An illustrated account of the experiments of Mercanton on this subject.—*Scientific American,* May 7.

POWER.

Power Station Design.—MERZ AND MCCLELLAN.—The first part of a paper read before the British Institute of Electrical Engineers. The authors think that since the early days of the distribution of electrical energy, an amount of attention has been directed to the power station as compared with the distribution system which is hardly warranted by its importance from either an engineering or commercial standpoint. The expenditure upon the distribution system is probably, in the majority of cases, more than 50 per cent. of that on the whole scheme, especially if the consumer's installation be taken into account. The distribution system has a comparatively high efficiency, probably not less than 75 per cent. On the other hand, the power station has a comparatively low efficiency, not more than 10 per cent.; there is thus room for large improvements in the generation of power. For this reason the depreciation accounts must necessarily form a much higher percentage of the capital cost than in the cost of the distribution system. A power station is capable of easy extension without effecting in a very marked degree the ultimate cost; it can, therefore, be begun on a smaller scale. It may pay in future to change even the location of the station. The authors suggest that 10 per cent. per year should be considered as sinking fund in deciding whether to spend more money than is absolutely necessary on any particular section of the plant in a power station in order to secure lower running costs. The relative importance of capital costs and running cost may be seen at a glance for any particular values of either load factor, capital cost or running cost from the curves shown in Fig. 2. It will be seen that a reduction of the capital outlay by £1 (about $5) per kw has a greater effect on the running cost than has a reduction of the coal bill by 6 per cent. This applies with a load factor as high as 30 per cent.; it is, therefore, evident that for lower load factors the question of limiting capital expenditure becomes of overwhelming importance as compared with that of reducing running cost. The authors emphasize the importance of simplicity of design and recommend to subdivide all parts of the plant and apparatus, from the boiler house to the switchboard, into a series of units each complete in itself. Labor-saving devices are becoming more and more desirable, but their installation should be carefully considered. On the one side should be put capital charges, taken at not less than 15 per cent. of the capital cost and repairs, the latter to be estimated. On the other side should be put the saving in labor. Provision should always be made for extensions. The authors then discuss the actual design of a plant generating three-phase, high-tension currents at 5,000 volts or more. They first deal with the type of generating plant. High-speed reciprocating engines cost for the same power less than those of low speed, and will take up less room. On the other hand, the advocates of low-speed engines claim that the repair bill of a high-speed engine is higher and the economy not so good. The authors speak very favorably of steam turbines and give the results of tests of a 2,000-kw Parsons steam turbine which was installed at Wallsend in 1901. This turbine was run 7,500 hours without ever having been opened up, and only on two occasions have the bearings needed any resetting in order to keep the clearance correct, although

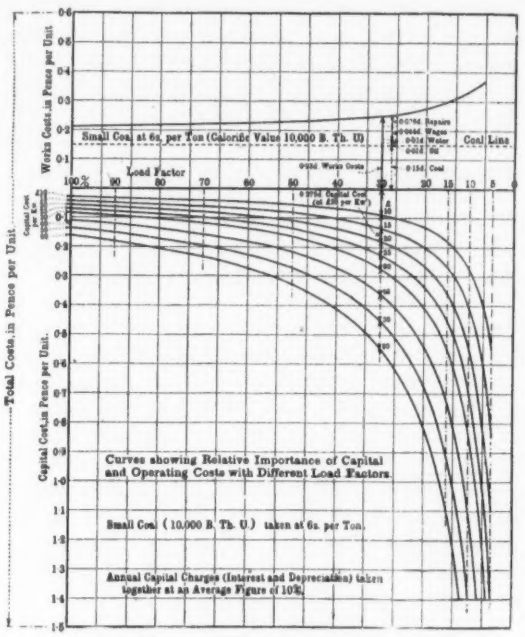

Total Costs in Pence per Unit
Capital Cost in Pence per Unit
Works Costs in Pence per Unit
Small Coal at 6s. per Ton (Calorific Value 10,000 B. Th. U)
Load Factor
Coal Line
Curves showing Relative Importance of Capital and Operating Costs with Different Load Factors
Small Coal (10,000 B. Th. U.) taken at 6s. per Ton.
Annual Capital Charges (Interest and Depreciation) taken together at an Average Figure of 10%.

FIG. 2.—CURVES SHOWING COSTS.

they were three times examined and the clearance tested. The only faults of any kind which it has been necessary to repair have been the relining of one of the governor throttle valve chests and the renewal of an oil disc. "Steam turbines seem in every respect to be specially suitable for power scheme purposes, and, although they have taken many years to develop, it is probable that, had there been a demand 10 years ago for 2,000-kw generating sets, turbo-alternators would have been the only large-size generating units in extensive use at the present day." The authors prefer steam turbines to gas engines and draw the balance sheet as follows: Gas engines—Low coal bill, high oil cost, high labor cost, high repair cost; and, most important of all, high capital cost. Steam turbines—Low oil cost, low labor cost, low repair cost; and, most important of all, low capital cost. In the coal bill there is a slight difference in favor of the gas engine. The authors then discuss the general arrangement of a central station. They recommend that the auxiliary buildings, repair shops, stores and all sidings should be put down before the buildings are

started. With regard to the general layout of the main buildings, the modern station is tending towards what may be called the complete unit system. For a large power station this tendency might with advantage be carried further than is the general practice at present, so that the only junction between the various units will be: First, at the railway siding or other source of coal supply; second, at the river or other source of circulating water supply; third, at the main bus-bars. In fact, a large power station might with advantage be so designed that the boiler house plant, the steam piping system, the generating system and the switchboard may all be entirely subdivided into different units.—Lond. *Elec.*, April 29.

Belgian Colliery.—A description of the electric installation of a Belgian colliery. A 250-kw generator furnishes three-phase currents at 1,000 volts. More than 75 per cent. of the output of the machine is used for running a winding engine installed underground at a depth of 525 meters. The motor runs at 415 r.p.m. with a normal output of 125 hp, the maximum torque developed under certain working conditions corresponding to 300 hp. It is an induction motor with the slip rings placed outside o fthe bearings in a gas-tight box and is fitted with power and electric brakes, and can also be braked by means of a counter weight, which cuts the motor circuit. The machine is also equipped with an electric device to keep the cage clear of the sheaves, and a side indicator. The balance of the energy is used for pumping and lighting.—*Mines & Minerals,* May; from *Colliery Guardian,* January 29.

Coal Mining.—Harris.—An illustrated description of the Ernest plant of the Jefferson and Clearfield Coal & Iron Company, at Ernest, Pa. The electric equipment consists of two multiphase 300-kw, 575-volt generators. Electric power is used mainly for haulage. There are provided ten 10-ton and one 20-ton, 500-volt mining locomotives. Each of the 10-ton locomotives has a cable extended so that two may be coupled together electrically. This arrangement gives many of the advantages of the 20-ton locomotive and permits a 10-ton locomotive to be used separately when one of them will do the work. Traction advantages are also claimed for the combination over the single 20-ton locomotive.—*Mines & Minerals,* May.

Traction.

Direct-Current Versus Single-Phase for Traction.—Hobart.—The first part of an article in which the author points out that it is unreasonable to disregard the undeveloped possibilities of the direct-current motor, especially in the matter of operation at higher voltages, in connection with traction. The author does not deny the possibilities of a single-phase system for main line work, but points out that, contrary to expectations, it is not so much for main line work, but more especially for urban, suburban and interurban work that the single-phase motor is at present strongly advocated. Compared with the direct-current motor, the single-phase motor has a larger commutator, greater commutator losses, no better commutation, a higher voltage per turn in the field spools (with increased danger due to a break-down in the insulation), larger internal losses and smaller efficiency; moreover, the power factor of the single-phase commutator motor falls considerably short of unity for all excepting a very narrow range of loads; and with this system considerable auxiliary apparatus is required on the car. The author then criticises Lincoln's comparison of alternating versus direct current for interurban traction systems (Electrical World and Engineer, December 3, 1903), and points out that in this comparison for a 60-mile interurban line, 600 volts is taken for the direct-current system and the cost for the secondary network amounting to 30 per cent. of the total cost of the electrical system is deduced. "In fact, it is only by comparing a 3,000-volt secondary network for the single-phase system with a 600-volt network for the continuous-current system that an advantage appears to be obtained for the single-phase system." The author offers the following criticisms of Lincoln's estimate: that it is overlooked that single-phase generators cost some 30 per cent. more than polyphase generators for the same rating and guarantees; that the increased cost of low frequency transformers is overlooked; that there is no reason to use many small and expensive single-phase transformers for the polyphase central and sub-stations (although this has been formerly the practice in the United States); that the single-phase generating plant is not sufficiently liberally proportioned, in view of the average power factor; that since the chief handicap of the direct-current system is the low-tension, the voltage should have been increased, as this is a perfectly sound proposition in the present state of the art; that large transformers are artificially cooled and some attendance is advisable even for single-phase sub-stations. The high voltage per turn in the field spools of the alternating-current systems, the less satisfactory commutation and the more complex auxiliary apparatus will inevitably result in a higher percentage depreciation than for the direct-current equipment; nevertheless, Lincoln takes 10 per cent. for the former and 12 per cent. for the latter. The article is to be concluded.—Lond. *Elec. Rev.,* April 29.

Tramcar Control.—An illustrated description of a regenerating system of tramcar control, devised by Raworth. The article is based on two recent English patents. The first patent refers to the regulation of shunt-wound motors by means of controlling both the field circuit so that the armature circuit cannot be made or broken until the field is excited to a maximum. The second patent refers to the return of energy to the line when the car descends a gradient. The motors are compound-wound and the series windings are arranged to strengthen the field when the armatures are returning energy, and, therefore, to weaken the field when the motors are receiving energy from the line. In starting the car, the series field winding is short-circuited and has no effect on the field. To increase the speed the driver pushes the speed lever and the braking handle moves with it, the shunt field being reduced by the insertion of resistance. If the speed increases too much, he draws back the speed lever, thereby removing resistance and strengthening the field. In descending steep hills, the driver first draws back the speed lever until the increased strength of the field returns a strong current to the line, and then, if more retarding effort is required, he pulls back the braking lever, the effect of which is to remove the short-circuit of the series winding and to still further strengthen the field. The controller may be so arranged that in case of emergency, for instance, the trolley leaving the line, further motion of the lever and handle will short-circuit the armature through the series winding, thus bringing the car to a stop or nearly so. No other brakes are necessary than the hand brake to hold the vehicle when stopped; but should the trolley leave the trolley wire, then, unless additional braking means are provided, there is great liability of a serious accident taking place. Means are, therefore, provided to let the motor then act as generators and also as a very powerful brake. All the arrangements are described in detail and illustrated.—Lond. *Elec.,* April 29.

Germany.—An article on the financial results of electric railway operation in Germany. Electric traction has proved there much more costly than was anticipated when electrification was inaugurated, this increase being due chiefly to the higher charges for power, maintenance of track and rolling stock, wages, accident costs and pavement repairs. The only favorable factor which has enabled most of the companies to continue on a paying basis has been the unexpected increase in traffic. The fever for municipalization has abated in view of the results attained on most of the municipal lines as compared with private ones under similar conditions.—*St. R'y Jour.,* May 7.

References.

Three-Phase Traction.—Kando.—In the continuation of his polemics with Lalino he emphasizes that the operation of the Vattellina road has completely proven the practicability of braking with the cascade system and the possibility of winning back energy when running down hill, so that with a road for which saving of energy is of important value reliance can be placed on the above two factors.—*Elek. Zeit.,* April 28.

Noiseless Fuse.—An editorial on the use of a noiseless fuse on large cars, especially elevated railway cars, where a panic may be produced by the burning of the ordinary fuse. It is thought that the fuse could be encased in a porcelain enameled steel shell with a muffler at each end.—*St. R'y Jour.,* April 23.

Wires, Wiring and Conduits.

Inductive Voltage Drop in Three-Phase Lines.—Lichtenstein.—The first part of an illustrated article referring to some errors which may occur in connection with voltage measurements of a three-phase line. He has found in practice that in an auxiliary wire used for measuring purposes, voltages may be induced even if the distance of this auxiliary wire from the three main wires is relatively very large. He also found that the formula for calculating the inductive voltage drop of parallel alternating-current conductors is no longer valid for three-phase lines, and that the inductive voltage drop must be specially calculated in each case. He gives the mathematical theory of the subject and shows conclusively that in the auxiliary wire voltages are induced of such magnitude that they may in-

fluence the result considerably. If the three wires for the three-phase system are in one plane (as is generally the case in three-phase traction installations) he shows that in the auxiliary wire voltages are always induced whatever may be the distance from the three main wires, for instance if this distance is even greater than 8 meters. The article is to be concluded.—*Zeit. f. Elek.* (Vienna), April 24.

REFERENCE.

Eddy Currents in Cable Sheaths.—FIELD.—Two mathematical supplements to his paper abstracted recently in the Digest. In the first he discusses the distribution of induction and eddy currents in a long iron pipe, enclosing an alternating current. In the second the magnetic fields due to various systems of straight parallel conductors are considered, it being assumed that the conductors are circular in section and that the distribution of current over the cross-section of each conductor is a function of the distance from the axis of the conductor only.—Lond. *Elec.*, April 29.

ELECTRO-PHYSICS AND MAGNETISM.

Electric Origin of Rigidity.—SUTHERLAND.—A highly theoretical paper on "the electric origin of rigidity and consequences." The author endeavors to substitute the "doublet theory" for the electron theory, a doublet being a combination of two oppositely charged electrons. The chief difference which the doublet theory of valency makes when substituted for the electron theory is that for over doublet which the electron theory would require on account of the attraction of opposite electrons the doublet introduced an inner doublet whose electrons are very close together. In his theory the most important characteristic of the molecules in metals is that each atom contains in itself both a positive and negative electron. Rigidity at absolute zero is a purely electrostatic affair, but its variation with temperature is a simple kinetic phenomenon. The electric doublet forces the material atom to vibrate. The combined existence of electrostatic and electrokinetic energies in the same pair of electrons is conceived by imagining the electrons to travel over the surface of the atom in curves similar to screws having a small pitch, so that the motion parallel to the axis of the screw negligible in comparison with that around it. The average distance along the axis of the screw between the two electrons is the distance, s, which gives the pair of electrons the electric moment, $e\,s$. The electrokinetic energy of motion round the axis and the electrostatic energy due to separation of charges along the axis, may both be regarded as a store of energy. Since the pair of electrons in an atom of metal possesses electrokinetic energy by virtue of the rotation of the electrons around an electric axis it must have gyrostatic properties. Each atom is equipped with an electrostatic doublet and an electrical gyrostat, both having the same axis. In the metallic conductor all the gyrostats vibrate in a field of electric force, like a number of spinning tops in the field of gravity. The monatomic atom of a metal with its doublet he calls a stion. Metallic conduction is due to the dissociation of stions, electrolytic conduction to the dissociation of molecules. In metallic conduction there is a breaking of molecular gyrostats and the flying together of the broken pieces. The author discusses at some length the consequences to which his theory leads concerning electrical and thermal conductivity in metals. He then deals with the contact difference of potential and the mechanism of the storage of potential chemical energy in the ether. He finally uses the neutron structure of the ether for the calculation of its density and rigidity and the deduction of the velocity of light. The author distinguishes three distinct ways in which kinetic energy can exist in the ether; first by rotation of an electron round its center, connected with magnetic permeability of the ether; second, by rotation of neutron, which is the same as translation of electron; and third by motion impressed on the doublets of matter by the atoms, this being the origin of radiation.—*Phil. Mag.*, May.

N-Rays.—COLSON AND MEYER.—Two French Academy papers on this subject. Colson is of the opinion that the N-rays are capable of being utilized as a delicate chemical reagent of considerable value. Some chemical reactions are the source of N-rays, while other and very similar ones are not. In preparing zinc hydrate the result is the same whether zinc sulphate is added to caustic potash solution or the latter is added to the former. But in the latter case, the reaction gives rise to N-rays, which diminish the brightness of a phosphorescent screen, whereas the reverse process does not give rise to the rays. This evolution of rays is accompanied by the formation of a basic salt which is only formed as long as the zinc sulphate is in large excess. Calorimetric tests show that the formation of this basic salt gives rise to a greater quantity of heat than the formation of the zinc hydrate without such an intermediary stage. Meyer has discovered some new sources of the extinguishing rays called by Blondlot N-rays, and has obtained rays of a higher penetrating power than heretofore. If a screen with patches of phosphorescent calcium sulphide is placed in the receiver of an air pump and the pump is worked, the prosphorescence decreases, being restored as soon as the pressure is restored. The same thing happens if the screen is placed outside instead of inside the receiver. An incandescent lamp through which no current passes, or a vacuum tube, are powerful sources of N-rays, the strain of the glass under atmospheric pressure being sufficient to account for their production. —*Comptes Rendus*, April 11; Lond. *Elec.*, April 29.

ELECTRO-CHEMISTRY AND BATTERIES.

Formation of Hydrogen and Oxygen Gases by Alternating Currents.—VAN NAME AND GRAEFENBERG.—An account of an experimental investigation in which the output of formation of hydrogen and oxygen gases by alternating currents and the voltages applied were measured with platinum and gold electrodes in sulphuric acid and with silver, nickel and copper electrodes, in potassium hydrate. The frequency was held constant at 55 periods per second and the current density was varied. The largest efficiencies obtained were only about one-half of that which can be obtained with direct current. Moreover, these efficiencies could be maintained only for a limited time on account of the electrodes being attacked. Concerning their suitability as electrodes, a number of substances were examined, but no entirely satisfactory substance was found.—*Zeit. f. Elektrochemie*, April 29.

REFERENCES.

Calomel Electrode.—LEY AND HEIMBUCHER.—An account of an experimental investigation on the concentration of the mercury ions in the calomel electrode and on the solubility of calomel. For the concentration of the mercury ions in the 0.1 calomel electrode, and in the .1 normal calomel electrode they find the values 2×10^{-16} and 3.5×10^{-18}, respectively.—*Zeit. f. Elektrochemie*, April 29.

Influence of Light upon the Formation of Lead Accumulators.—SCHOOP.—A note with reference to a recent article of Tommasi, whose results he confirms. He describes the following experiments: A peroxide lead plate, formed according to Planté, was cut into three parts, of which one was left in the dark, the second in the daylight, and the third was placed in the direct rays of the sun. The color of the latter two changed appreciably after some hours.—*L'Eclairage Elec.*, April 30.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring Small Inductances and Capacities.—FLEMING.—A description of a convenient method for measuring small inductances. The arrangement is illustrated in Fig. 3. The inductance, L, is

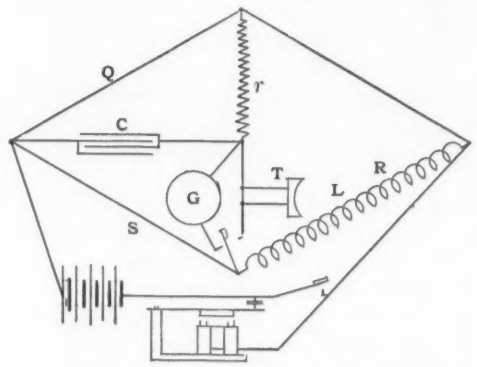


FIG. 3.—DIAGRAM OF ARRANGEMENT.

given by the formula, $L = C\{r(R + S) + RQ\}$. In this equation L is the inductance and R the resistance of the coil being measured, C the capacity of the condenser consisting of one or more Leyden jars (or a mica condenser), S and Q are the resistances of the adjacent and opposite bridge arms, and r is the resistance inserted in series with the telephone in the bridge circuit, a resistance box being used for r. The steady balance is first obtained in the usual way with the galvanometer and steady current. If the

telephone, *T*, is substituted for the galvanometer and an ordinary buzzer is used in the battery circuit to interrupt the current at the rate of about 100 per second, and when *r* is adjusted to produce silence in the telephone it was found that variations to the extent of about one per cent. either way and sometimes much less caused the sound to reappear in the telephone. The author has found that solenoid coils constructed by winding silk-covered copper wires in one layer and in closely adjacent turns on a glass rod, have an inductance which is very nearly equal to the length of wire per unit length of solenoid multiplied by the total length of wire used to form the solenoid. This rule is correct as long as the length of the solenoid is at least 50 times that of the diameter. The above arrangement may also be used to determine the capacity in the bridge, assuming the value of the inductance calculated from this formula. On the basis of this formula he describes a method for the calibration of a variable inductance for use for certain resonance experiments.—*Phil. Mag.*, May.

REFERENCES.

Measuring Conductivity of Wires.—APPLEYARD.—A description of his conductometer, which is a direct-reading instrument intended for the comparison for electric conductivity of copper and other wires, for a range within, say, 5 per cent. above and 5 per cent. below 100.—*Phil. Mag.*, March.

Rymer-Jones.—The first part of an article in which the author doubts the advantages of the conductometer over the simple meter bridge.—Lond. *Elec. Rev.*, April 29.

Meters.—A description of the following meters which have been accepted for calibration by the German Reichsanstalt: A direct-current motor meter, a single-phase induction meter and a three-phase induction meter, all made by the Union Electric Company, of Berlin. The construction and method of calibration of the instruments are described in detail and exact drawings are given.—*Elek. Zeit.*, April 28.

Hot-Wire Ammeter.—FLEMING.—An illustrated description of a hot-wire ammeter for the measurement of very small alternating currents. Currents as small as two milliamperes can be measured and the instrument can essily be calibrated at the time of using it. As an instance of the application of the instrument he gives the measurement of the magnetizing currents of small transformers.—*Phil. Mag.*, May.

MISCELLANEOUS.

Lightning Rods.—KIRSTEIN.—An article urging the erection of lightning rods on buildings in rural districts. Care should be taken to examine them regularly concerning their efficiency.—*Elek. Anz.*, April 28.

Asbestos.—An illustrated article on the equipment of the works of the United Asbestos Company with a general description of the methods of mining and treating asbestos and of its various uses.—Lond. *Elec. Rev.*, April 29.

New Books.

CONGRES DE LA HOUILLE BLANCHE. Grenoble, France: Syndicat des Forces Hydrauliques, Chambre de Commerce. 2 vols. 1,270 pages, illustrated. Price, 30 francs; with foreign postage, 31 francs 50 centimes.

These massive and handsome volumes are devoted to a record of the remarkable Congress held at Grenoble in September, 1902, to develop the subject of the utilization of water powers in general, of those of France particularly, and peculiarly those of the region in which the congress was held. As the readers of this paper know, the French describe water power in a happy phrase as "white coal," or "houille blanche," and it will also be remembered that at the time of the meeting a large amount of space was devoted in these pages to a report of the work done. We find here, however, all the papers in full and a verbatim record of the discussions. Even this does not convey the full meaning and importance of the affair, for the men who participated while not all of them known personally or by name in America, were Frenchmen of distinction, of talent and genius; and their work in this convention was done with a skill and thoroughness that must evoke intense admiration wherever it is studied.

The first volume is devoted to the papers and discussions, all, as we have intimated, of an admirable quality and high order of merit, dealing not alone with engineering aspects of the question, but with legal, industrial, commercial, social, each handling its topic with characteristic French sanity and lucidity and compelling one to stop and read at almost every page. The second volume takes the theory of the first volume and shows how it has all actually been worked out in practice in that splendid water power region of Haute Savoie, which, running south from Bellegarde, finds Grenoble as its center. What has been done there is exemplified in hundreds of cuts, accompanying the description of the trips which were undertaken by members of the Congress. In short, the student of water power development who has these volumes at his elbow is fortunate, and without them he is far from being fully acquainted with his subject. It may be added that the utilizations are quite largely electric—lighting, trolleys, power service, electrochemistry, etc.

ELECTRICAL ENGINEERING EXPERIMENTS AND TESTS ON DIRECT-CURRENT MACHINERY. By George F. Sever. New York: D. Van Nostrand Company. 64 pages, 22 illustrations. Price, $1.00.

This is a compilation of tests on direct-current machinery, primarily adapted for the direction of third-year students in the shorter laboratory courses of electrical engineering at Columbia University; and secondarily for those who may, in the practice of electrical engineering, desire a synopsis of the simpler tests on direct-current dynamo machinery.

A series of experiments is detailed in the book. These are: (1) The measurement of fall of potential along a wire. (2) The measurement of resistance by fall of potential. (3) The measurement of higher resistances by Wheatstone bridge. (4) The operation and tests of a shunt-wound constant-potential dynamo. (5) The operation and tests of a compound-wound dynamo. (6) The operation and tests of a shunt motor. (7) The operation and tests of a series motor. (8) Tests of a dynamo or motor by the stray-power method. (9) Operation of shunt dynamos in parallel. (10) Operation of compound dynamos in parallel. (11) The operation of a constant-current dynamo, and of arc lamps.

These experiments are clearly defined and described. The diagrams of connections are given, and also tabular forms for recording the observations.

The pamphlet will be of distinct value to students of electrical engineering not only in college, but also wherever direct-current machines have to be operated and tested. The treatment is in conformity with the standardization rules of the American Institute of Electrical Engineers and the notation is in the international system.

A Self-Cohering Receiver.

BY EDWARD VAN WINKLE.

It is doubtless true that no one at present engaged in the wireless business is entirely satisfied with the results obtained; and the indifferent success has been charged, by a great majority of the wireless people, to the inefficiency of the initial spark as employed in the past, and they have looked for the solution of this fault in the stepping up of the initial spark, with the hope of improving the signal received. In analyzing, however, the defects of instruments as they become apparent through application and use, a radically different view of the remedy required to produce clear signals, has been proposed, the position being that the initial energy of the spark was sufficient, but that the energy contained in the impulse was lost in the faulty construction of every known wireless receiver; that the imperfect signals received were due to the fact that all wireless receivers had their local circuits legged off the antenna and ground wire, thus bridging across the fluctuating point in the receiving instrument and providing a circuit around the fluctuating point instead of through it; and as these local circuits carried less resistance than any known coherer, or anything else used as a fluctuating point in wireless receivers, a great proportion of the impulse assembled on the antenna passed around the fluctuating point while passing to the earth and was lost. Here lay the reason for the indifferent success, and a solution was, not to step-up the initial spark, but to insulate the wave circuit from the local circuit and prevent a loss of the wave energy after contact with the vertical wire.

This principal is applied on the Peters self-cohering receiver, to which the accompanying illustrations refer. In this the local circuits are entirely insulated from the wave circuit, and yet be capable of duplicating in the local circuit the electrical phenomena constantly

taking place in the wave circuit as the impulses pass through it to the earth. On several occasions controllable signals have been received over a distance of three miles using only the spark of a single "Mesco" dry cell.

Referring to the illustrations, Fig. 1 is a diagramatic sketch of the receiver, Figs. 2 and 3 sections of the coherer, and Fig. 4 is a photographic view of the coherer, motor-driven, with a regular Morse sounder on the right; the ground wire is shown in foreground.

The coherer includes two electromagnets 1, placed in reverse with

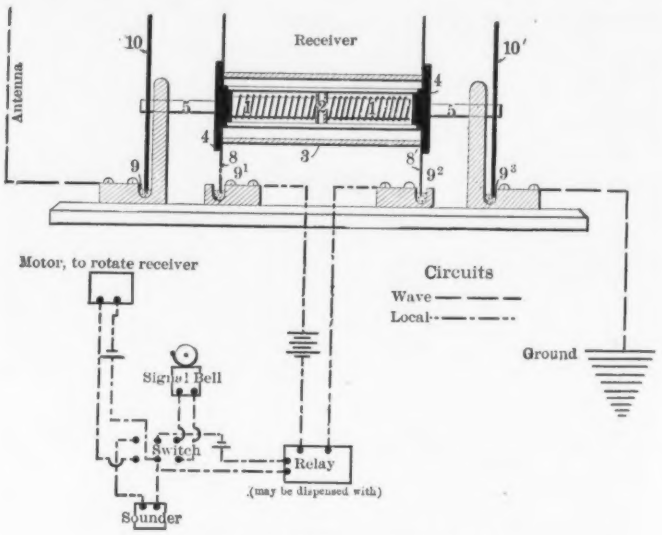
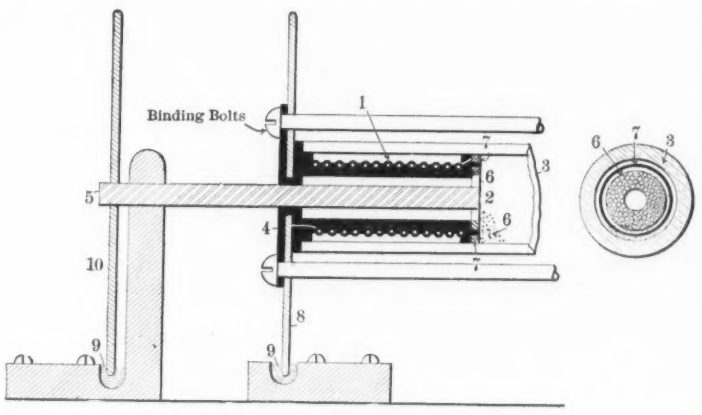


FIG. 1.—DIAGRAM OF CIRCUITS.

the filing-gap 2, between their ends in a glass tube 3, sealed by insulating end plates 4. Both electromagnets have for a core the shaft 5, around which are placed a number of soft iron wires secured at the gap end by a ring of soft iron 6, which is insulated from the soft iron ring 7. This latter ring is the terminal of the coil at the gap end, the other terminal of the coil being the discs 8. The wall of the filing gap is formed of the ends of the core and the insulated terminal ring of the coil, all of which is clearly shown in the illustration.

The coherer is rotated by the motor shown diagramatically. The shaft of the coherer on the left is connected to the antenna, or vertical wire, through the mercury well 9, and the disc 10. The other shaft is connected to the earth through the mercury well 9^3 and the disc 10^1. The coils of the electromagnet are in relay or local circuit through the discs 8 and 8^1.

The bell is in circuit when the switch is thrown to the right, and



FIGS. 2 AND 3.—SECTIONS OF COHERER.

is used only to notify the operator that a message is about to be received. As soon as the filings are magnetized the bell circuit is closed through the batteries and relay, and the bell rings. The operator then throws the switch to the left, which throws both the sounder and the coherer motor in circuit; the coherer then revolves and is ready for message. The iron filings in the gap between the ends of the electromagnet should fill about one-third of the gap, or sufficient to lap the core and coil terminals at all times. When the receivers is in motion the filings as a mass are carried around with the tube, until raised above the angle of repose, when they break away at the top and falling over themselves, reform again at the bottom to be carried up again in endless repetition; this being the decohering process constantly maintained by the rotation of the tube. It will also be noticed that between the top of the mass where the filings break away, and the bottom where they reform, is an area of filings never disturbed with respect to their contact with the walls of the gap (coil terminals); this mass of undisturbed filings is always ready to be cohered when a wave of very high potential passes through, notwithstanding their continuous rotation.

No other type of coherer gives as clear a signal as a filings coherer, and its defect of lack of speed owing to the filings requiring to be tapped is overcome by decohesion secured through rotation. The sensitiveness of this coherer is evident from the fact with the usual filing mixture, 90 per cent. of nickel and 10 per cent. of silver filings it would cohere too thoroughly to permit of decohesion under the influence of the electromagnetic coils; this compels the use of ordinary iron filings mixed with 40 per cent. of brass filings in order to introduce in the mass a non-magnetizable metallic weight as a roving element in the mass, to break down the perfect state of cohesion maintained by the coils.

The fluctuating point in the local circuit is established by placing sufficient filings in the gap. The wave or impulses entering through the core of the electromagnet coheres the particles and closes the local circuit, the effect of which is to assist or increase the cohering action by energizing the cores.

The cores of the electromagnets constitute the wave circuit and the coils the local circuit, thus completely insulating them, and leaving the local circuit free to energize the cores of the coils when the impulses cause the local battery to flow, by magnetizing the filings that lay between the terminals of the two coils. In this way the local battery is utilized to assist in perfecting cohesion, the wave in the instrument being utilized only as a trigger to start the local batteries to flow, which by their local action complete the act of cohesion.

The mercury wells shown in the diagram, and the wheels rotating therein, are for the purpose of making continuous contact between the movable and stationary parts of the instrument; commutator contacts will be employed in the future construction of the instrument to accomplish this purpose.

The change of potential in this receiver is equal to the actual opening and closing of a circuit, thus giving variation of current sufficient to operate an ordinary set of Morse telegraph instruments giving audible signals, clear enough to be received and copied while operating a typewriter.

The advantages claimed for this device over all others are:

1. Its absolute simplicity. 2. It requires no adjusting after being correctly constructed. 3. Any number of instruments can be operated on the same antenna. 4. It will enable a receiving station to break a sending station. 5. An operator can read the message that he is sending off his receiving instrument. 6. The instrument will receive a wireless message and repeat it to a telegraph line, and vice versa. 7. The filings being always in position for action, and no time being lost waiting for their recovery, a much greater speed can be secured than with a coherer in which the filings are scattered

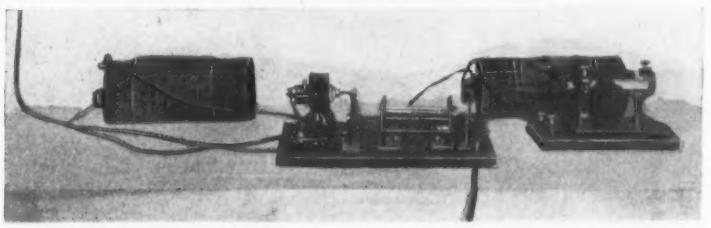


FIG. 4.—VIEW OF MOTOR-DRIVEN COHERER.

by tapping or dumping. 8. Owing to the assistance given the waves by the electromagnetic coils in cohering the filings, a message can be received at greater distances and from weaker signals than by other instruments. 9. The wave and the local circuits being insulated from each other, no part of the impulse is lost through the legged or local circuits. 10. As the entire mass of filings is decohered by one-tenth of a revolution of the tube, and as the tube decoherer is safely under eight revolutions per second, the make and break of the circuit can occur eighty times per second. 11. This coherer is capable of changing the resistance in its gap practically equal to the absolute opening and closing of the circuit.

High-Voltage Oil Switches.

The oil switches shown in the accompanying illustrations, made by the Stanley Electric Manufacturing Company, are so designed that the circuit is broken simultaneously at several points, thus distributing the resulting disturbance over a considerable area. Moreover, for potentials above 6,600 the various contacts are arranged in the same horizontal plane, so that the disturbances resulting from the rupturing of the arc are distributed, rather than concentrated, as is the case where the contacts are one below the other. Another advantage of opening the contacts in a horizontal plane is that the arc tends to flare upwards, increasing its length and thereby securing a longer break than in the vertical type, with the same separation of contacts. The contacts are located comparatively near the surface of the oil, so that the gases resulting from the explosion are readily dissipated, and, by using comparatively large tanks and long breaks, the switch may be opened and closed many times before the oil is carbonized appreciably.

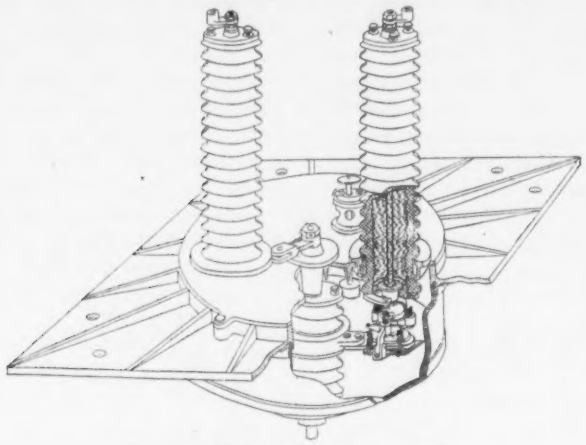


FIG. 1.—60,000-VOLT OIL SWITCH.

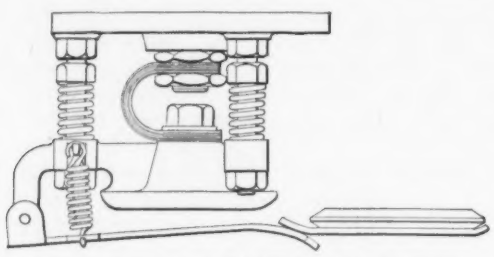


FIG. 2.—CONTACT OF 60,000-VOLT OIL SWITCH.

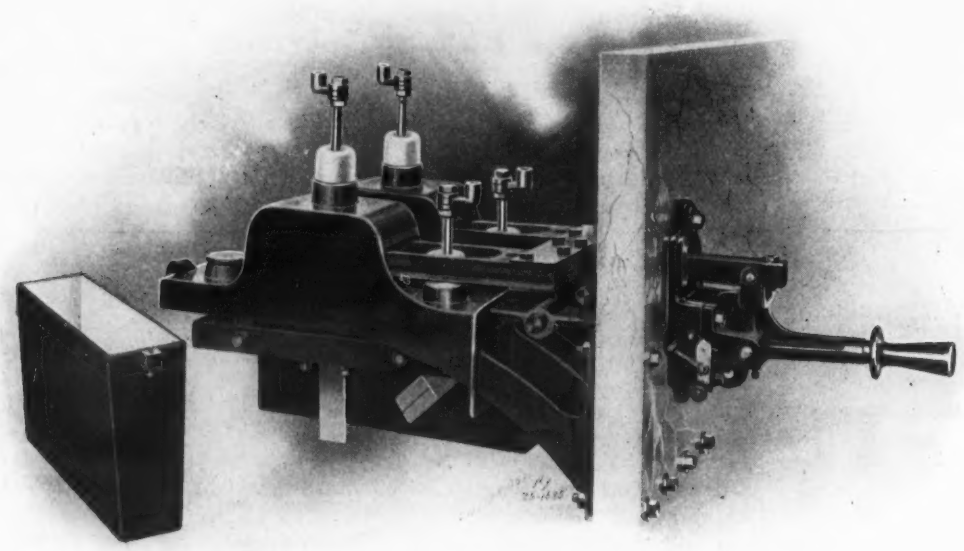


FIG. 3.—3,500-VOLT OIL SWITCH.

The principles of construction above outlined are embodied in a 300-amp., 60,000-volt switch, a number of which have been installed as a part of the equipment of the high-voltage transmission systems in the West. Fig. 1 gives an idea of the general construction of the switch. Each pole consists of, first, a cast-iron top or mounting plate, on which are mounted the two terminal contact insulators, a bearing of liberal length for the driving shaft, and a combined gas vent and automatic oil level indicator; and, secondly, a tank filled with oil in which are immersed the contacts suitably insulated. The insulators are of porcelain made in the form of corrugated cylinders. The center insulator carrying the contact blades is entirely immersed in oil. The two terminal insulators are partly filled with and have their lower ends immersed in oil. These two insulators are held in position by means of hollow clamp rings, which are fastened to the insulators with set-screws and cement. The contact blades are fastened to the central insulator in a similar fashion.

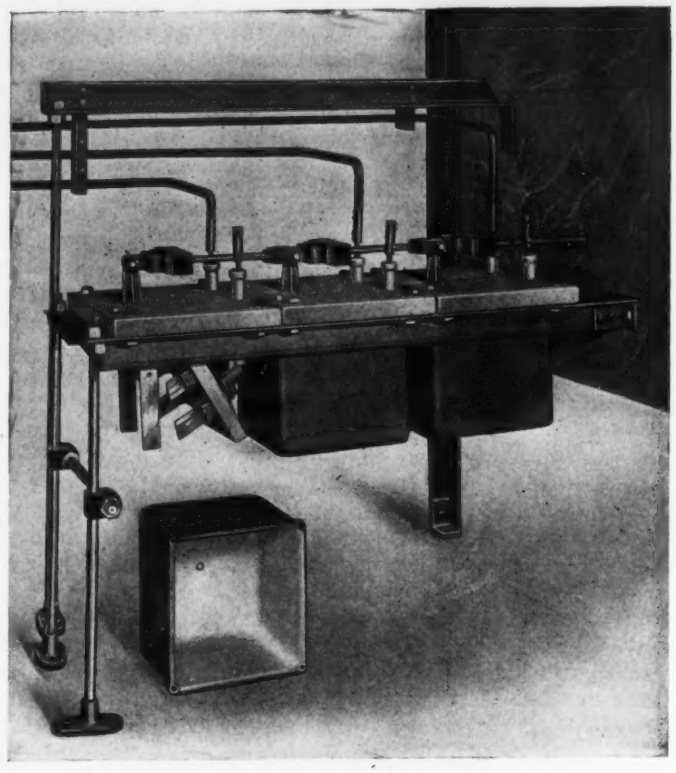


FIG. 4.—6,600-VOLT, THREE-POLE SWITCH.

Fig. 2 shows the details of a contact. The contact arms are of hard-drawn flat copper strips. Each fixed contact is forced downward by three coiled springs which are carried on the studs on which the fixed contacts slide, and which are screwed on the battom of the insulator. These fixed contacts, as well as the blades, have ground surfaces. On closing the switch, each contact blade slides under the corresponding fixed contact, and, owing to the arrangement of the springs, a perfect self-aligned contact results.

The shape and position of the shunt or arc-rupturing contacts are such as to prevent any possibility of the arc being taken by the main contacts. These auxiliary contacts are readily replaceable. In the illustration, the oil level indicator can be seen on the left of the insulator, the construction of which is exposed. Should the oil leak out, or, for any other reason, recede below a safe level, the indicator closes the pilot circuit and warns the attendant by ringing a bell or lighting a lamp, as may be desired.

Each switch is tested at 120,000 volts and, in installing, the iron

top and tanks are grounded, making it perfectly safe for the operator to handle the controlling device. The three-pole switch is made up of three of the units described above, connected by rods and the crank on each operating shaft to either a motor, magnet or hand-operated controlling device, and the operation of either of these devices may be controlled by plain overload, time delay overload or reversed current relays. Each pole of the switch may be mounted in either soapstone or brick compartment or upon iron framework.

Fig. 4 shows a three-pole oil switch for voltages up to 6,600, and for currents up to 100 amp. Each pole is in a separate tank, as is the standing practice for oil switches for potentials exceeding 3,000 volts. The tanks are mounted in a strong, yet light framework consisting of angle irons and rods. This switch is made with circuit-breaker attachment, if so desired, and either single or double-throw. One tank can be used as a double-pole switch with a capacity of 100 amp. at 2,400 volts, by connecting one blade to each pole. By connecting the blades in parallel, instead of in series, the switch may be used for 200 amp. at 4,000 volts. It is thus evident that this type of switch is readily adapted to meet a wide range of conditions.

Fig. 3 shows an oil switch designed for installations of not over 3,500 volts. It is made either single or double-throw and for any number of poles desired. The normal three-phase capacity of the switch is 400 kw and the emergency three-phase capacity is 1,200 kw; in other words, these switches should not be installed on circuits which have more than 400 kw normal capacity back of them.

The switch is also made with an automatic overload opening device When so furnished, the handle for closing the switch is not connected rigidly to the parts making contact, but is latched thereto, the arrangement being such that it is impossible to close the switch when there is an overload or short-circuit on the line. With this overload feature, series transformers are used, but one being necessary for either a single-pole or two-pole switch and two for either a three-pole or four-pole switch. As in the switches for higher voltages, there is a separate tank for each pole.

Silvered Mica Condensers.

For the benefit of those familiar with the construction of ordinary condensers it may be well to say a word about these before explaining the silvered mica condenser. In the ordinary condensers made of mica and tin-foil, the air between the surface of the tin-foil and the dielectric causes a variation in the capacity of the condenser, and if

FIG. 1.—ADJUSTABLE CONDENSER.

they are used on alternating-current circuits or subjected to inductive discharges, what might be called electrostatic bombardment will heat them to such an extent that they are liable to break down.

In the silvered mica condenser, these conditions as well as many others are overcome in a most marked degree. This condenser is made by depositing silver on mica. Figs. 1, 2 and 3 show forms of these condensers as manufactured by Messrs. Glifford H. Brown & Co., of New York City. Fig. 1 shows diagram of a 1-m.f. series-multiple and multiple-series standard condenser. It consists of ten 1/10 of a m.f. condensers. It will be seen from the diagram that these condensers may be used singly, in series, multiple, series-multiple and multiple-series, making many combinations possible. In the position in which the plugs are shown, two condensers are in

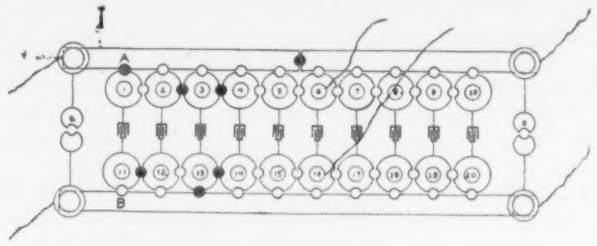


FIG. 2.—DIAGRAM OF CONDENSER CONNECTIONS.

series with two in multiple giving a capacity of .04 m.f. The range of this condenser is from 1 m.f. to 1/100 of a m.f.

Fig. 1 shows an adjustable 1-m.f. standard condenser, the minimum capacity being .025 m.f. This condenser is provided with a printed card, which slides in and out of the bottom of the box. On this card are marked the numbers of the plug holes to obtain the desired capacity. This card will be found of great convenience as well as a time saver.

Fig. 3 shows a non-adjustable standard condenser designed for high potential work. We are informed that Dr. Pupin is using a

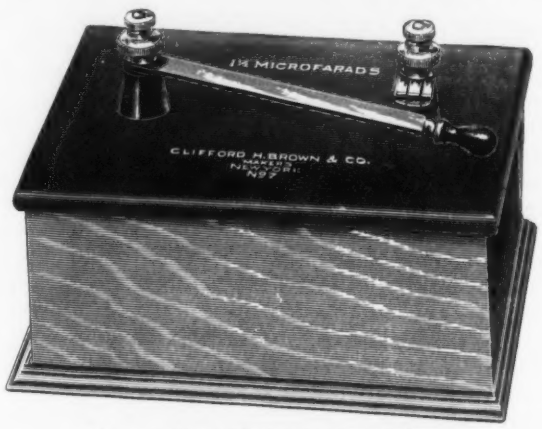


FIG. 3.—NON-ADJUSTABLE CONDENSER.

number of these condensers in connection with multiple telegraphy. These condensers are not only of value as standard, as above indicated, but may be used on high-potential alternating circuits without heating or changing capacity.

Water Power in France.

Mr. H. S. Brunot, United States Consul at St. Etienne, France, in a recently communicated report, says: "Besides the new water supply from the Lignon and electric power works belonging to the municipality of St. Etienne, which are now being constructed, there is another project being studied as a private enterprise which concerns the distribution of electric power and light not only to St. Etienne, but to all the principal towns of the Department of the Loire. M. Mallet, civil engineer at St. Etienne, is the promoter of this scheme and has great hopes of seeing it realized. The water will be taken from high up in the Department of the Ardèche, the source being a small lake 1½ miles in diameter. Certain dams and embankments will be constructed to increase the reservoir capacity of this lake, so as to guarantee a constant supply. The energy expected to be derived is calculated at 20,000 hp. All the industries of the region will benefit by these undertakings. Authorization to commence operations has been applied for from the French Chamber, and if the necessary sanction is given the use of electricity will be largely substituted for steam in this part of the country."

Western Electric Company's New Plant.

The Falkenau Construction Company has been awarded the contract for the erection of some more new buildings at the Western Electric Company's plant at Hawthorne, near Chicago. The principal building will be for the insulating plant and will be 401 x 200 ft. The total cost, with other lesser structures, will be about $142,000.

Lighting by Cooper Hewitt Lamps.

One of the novel fields of electric lighting which has seen the most rapid development since the National Electric Light Association met a year ago is that of vacuum tube work. A great deal more has been done in this department that is realized by the electrical public, while some of the installations are of a character to excite surprise even on the part of those who are well informed. As an example of the extent to which the mercury vapor lamp has been introduced, we illustrate herewith the battery room of the New York Transportation Company, on Forty-ninth Street and Eighth Avenue, New York City. This corporation operates the hundreds of electric hansoms and cabs to be seen in circulation on the streets of Manhattan Island, for the energizing of which a large battery room is required. The room is in fact slightly over 300 ft. long by 42 ft. wide, and 26 ft. high and, as can readily be imagined, it is a difficult place to light, not only on account of the darkness at almost all times, but because of the dense blackness of the storage battery boxes and the general absence of light-reflecting surfaces. Moreover, the frequent emission of fumes from the sulphuric electrolyte militates against the permanence of the ordinary electric light fixtures and appliances, so that from the first it has been found a difficult problem to light the space properly. The room was at one time lighted by fourteen 5-amp. arcs, taking, say, 60 to 70 amp. at 115 volts. It was necessary, however, to remove the mechanism of the arcs from the hood and to place it under a separate cover on account of the acid fumes from the batteries. There was, moreover, considerable difficulty in getting the arcs to work, and the results were never wholly satisfactory. Under all these circumstances, it was thought worth while to make a trial of the Cooper Hewitt mercury vapor lamp and 10 of these at 3 amp. each on the same 115-volt circuit have now been in use for about three months. The New York Transportation Company is very much pleased with the installation, and the current consumption is cut down about one-half. The lamps are run practically twenty-four hours a day. The general effect of the illumination can be seen from our half-tone cut, which, however, does not bring out the fact that the light given is so strong and penetrating that an examination of the batteries can now be made by the attendants with much greater ease and exactitude than ever was possible before.

While this may appear to be a large room for such illumination, we are able to give the data with regard to three other large spaces which the Cooper Hewitt Company has lit successfully. The table includes also the current consumption, the area lighted per lamp, and the area lighted per ampere consumed. Cooper Hewitt lamps are also being used very successfully in photography for taking pictures, for printing, for enlarging and for reducing. The photo-engraver also finds the lamp more economical of current, securing a more even illumination of the copy and faster printing on sensitized copper. A large amount of blue printing has also been done in this way as the tubes can easily be arranged in the regular solar blue print frame.

Character of work.	Area of Room.	No. of lamps.	Current Consumed. Amps.	Volts.	Area lighted per lamp.	Area lighted per amp.
Draughting room	2,140 sq. ft.	8	3⅓	110	265 sq. ft.	80 sq. ft.
Business office	1,100 sq. ft.	3	3.3	110	366 sq. ft.	110 sq. ft.
Leather factory	12,000 sq. ft.	30	3.3	55	400 sq. ft.	121 sq. ft.

For general illuminating purposes three types of lamp have now been developed. Two of these are of 700 cp. and the third is of 300 cp. One of these, known as the V-5 type, shown in Fig. 2, is the tube employed in the New York Transportation Company's battery room, and is started with a tilting method. The new type is of half size and can be operated two in series on 110-volt direct current. It is the type employed in business offices and for such places as the leather factory enumerated above. It is intended for general illumination and can be run in a horizontal position, whereas its predecessor, of the same candle-power, had to be run vertically or at

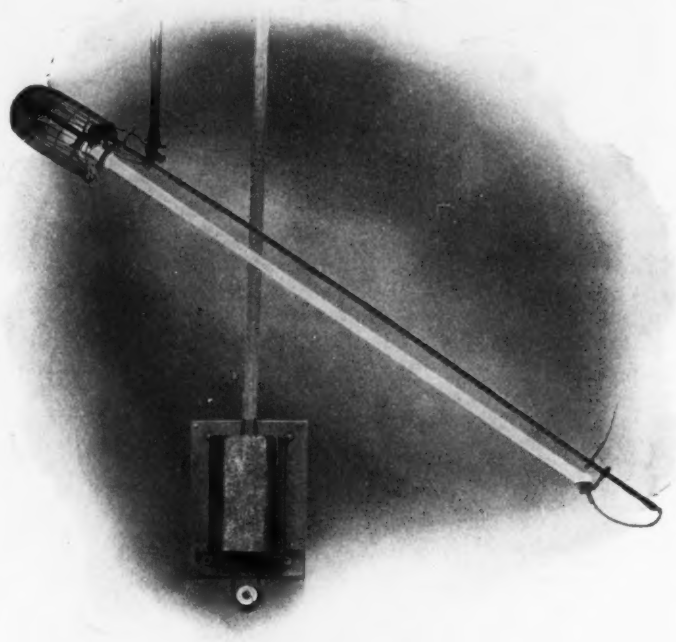


FIG. 2.—MERCURY VAPOR LAMP.

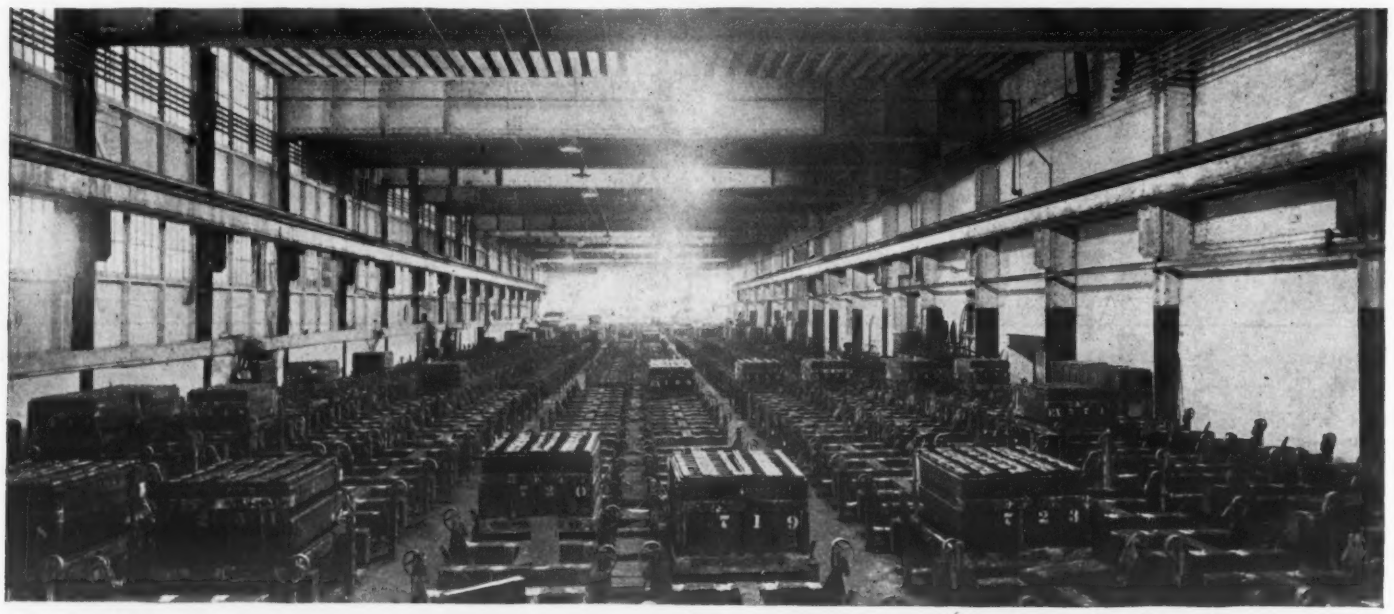


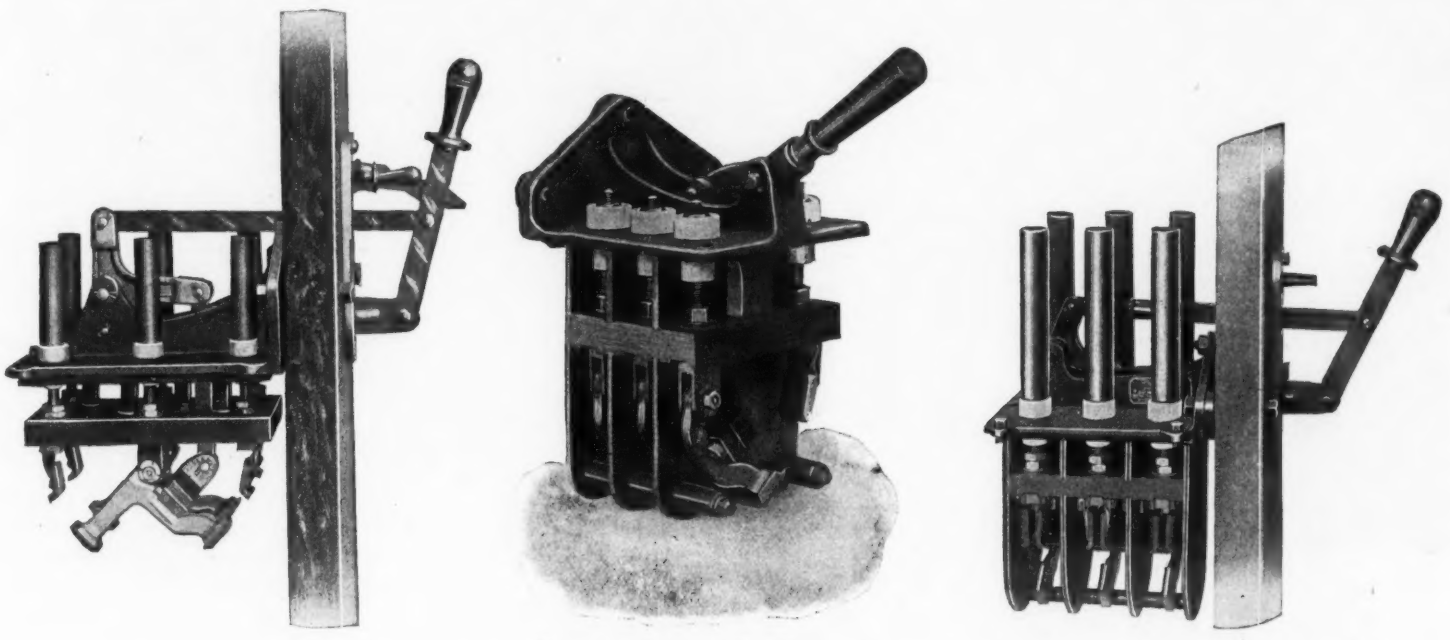
FIG. 1.—BATTERY ROOM OF NEW YORK TRANSPORTATION COMPANY, LIGHTED BY VAPOR LAMPS.

an inclined angle of 30° from the horizontal. These lamps are started bv the tilting method, which as a general thing appears to find preference over that involving the use of a kicking coil. Amongst recent orders for such lamps has been one of fourteen for James A. Hearn & Son, for their large dry goods store on Fourteenth Street, New York City. These tubes have been installed in their shipping and packing departments. It will be gathered from the above data that the Cooper Hewitt mercury vapor lamp has already made a distinct place for itself in the art and is rapidly gaining ground, not only in competition with older illuminants, but under circumstances which renders it peculiarly and sometimes exclusively available.

General Electric Oil Switches.

The extensive use of high-potential distribution systems and the widespread introduction of alternating-current motors and other devices introducing inductance have necessarily required radical changes in switches. The opening of circuits of considerable current value with inductive loads is not possible with old types of switches which were quite adequate for the service for which they were designed. These circuits are controlled with great facility and certainty by the oil switch, and this device is essential for the sure control of most modern alternating-current systems. Though of comparatively recent introduction, it has already been differentiated for many classes of service.

The accompanying illustrations show four types of such switches made by the General Electric Company. That of Figs. 1, 2 and 3, known as "Type F Form I," is designed to rupture loads which under emergency conditions cannot exceed 850 to 1,200 kw, three-phase, at potentials not exceeding 2,500 volts. Fig. 4 shows "Type F Form F" switch, designed to rupture loads which under emergency conditions cannot exceed 3,500 kw, three-phase, at potentials not exceeding 6,600 volts. In Figs. 5 and 6 are shown "Type F Form K" oil switch, designed to rupture loads which under emergency conditions cannot exceed 7,000 kw, three-phase at potentials not exceeding 13,000 volts. Finally, Fig. 7 shows "Type F Form H" switch, used for the interruption of circuits carrying power in excess of that which may be regarded as the limit of the switch of the other types.



FIGS. 1, 2 AND 3.—OIL SWITCHES.

The switches of Figs. 1, 2 and 3 are manufactured double, triple and four-pole, both single-throw and double-throw, and are designed in two forms: First, for mounting on switchboard panel, as shown in Figs. 1 and 3; and second, for mounting on separate base or wall, as shown in Fig. 2. This switch is adapted for use independently of a switchboard for the operation of induction motors, etc.

The cast-iron frame is designed to carry the mechanism, insulators and all live parts of the switch. Projecting lugs, from the under side of the frame, hold in position the base to which are attached the contacts and barriers. The switch is single-break—one end of the blade being clamped in a hinge clip by means of spring washers. The blades are joined together by means of a cross-bar, to which is attached the link for operating the switch. The stationary contacts are of the finger type, similar to those used in the General Electric street car controller. The oil vessel is supported from the frame and may be removed without disturbing any part of the switch. A red line indicates the proper oil level when the vessel is removed.

When in position on the switch all live parts and the base supporting the contacts are submerged in oil. The mechanism for working the switch mounted on the panel consists of an operating lever on the front of the board, which is connected by a link to a bell crank on the frame casting. The bell crank is connected to the cross bar of the switch by a second link. For the double-throw switches a lock is provided which prevents the switch from being thrown from one set of contacts to the other unless desired by the operator. This lock consists of two steel links pivoted on the escutcheon which locks the handle lever in the off position. When the oil switch is open it can be thrown on either set of contacts by lifting the locking handle which releases the catch. The switches, designed for mounting on separate base or wall, are equipped with a similar lock which is attached to the frame casting.

The use of this type of oil switch is recommended in connection with circuits which have to be opened under inductive load at voltages of 2,500 or less. The maximum load the switch will safely open is 700 kw single-phase, 1,200 kw three-phase, or 1,400 kw quarter-phase. It is designed in three current-carrying capacities, namely, 150, 200 and 300 amp.

The oil switch of Fig. 4 is manufactured especially for use on systems which require double-throw switches in connection with circuits of greater kilowatt capacity than that for which the above-mentioned switches are designed. It is designed for mounting on back of panel or for remote control, and is operated by means of a handle lever mounted on the face of the board. Double-throw switches are supplied with a locking catch which is released by means of a pull-rod passing through the panel. This lock has the same function as the locking catch o fthe oil switch described above and illustrated in Fig. 2.

The contact blades are carried upon a pivoted block of specially treated wood, and with the clips are supported from above by a cast-iron frame, forming a single element for mounting directly upon the switchboard panel or support. The oil vessel is supported from the frame casting as shown, and when in the operating condition the blades, blocks and all exposed live parts are completely submerged in oil. The oil vessel may be removed without disconnecting the switch or disturbing any other parts. The use of this switch should generally be limited to circuits where the double-throw arrangement is unavoidable. When single-throw switches of these

capacities are required the oil switch to be described later is preferable. The switch is made for voltages from 600 to 6,600 and currents from 125 to 300 amp.

The oil switch of Figs. 5 and 6 are designed single, double, triple and four-pole, and in two general forms, namely, the back of panel form for mounting directly upon the switchboard. This switch may be mounted upon a separate base equally well, and supported on an auxiliary framework. The second form is for remote control for operation in fire-proof cells or at points remote from the switchboard. Either form is arranged for hand-operation, being opened and closed by hand, and may be equipped with tripping devices which open the switches automatically on overload.

A cast-iron frame constitutes the body of the switch to which are attached all live parts and necessary operating links. The stationary contacts to which the leads are fastened are supported by insulators thoroughly insulating them from the frame casting. Controller finger contacts, which are readily replaced, are used instead of clips. A contact bar which moves in a vertical plane is carried by a rod of specially treated wood. In this manner a hinge contact is obviated and the switch made double-break. In case of double, triple or four-pole switches, the wooden rods carrying the contact bars are joined to a common cross-head which is lifted vertically in closing the switch. On the single-pole switches the rod is lifted directly by a lever, which is pivoted in the rear of the frame casting.

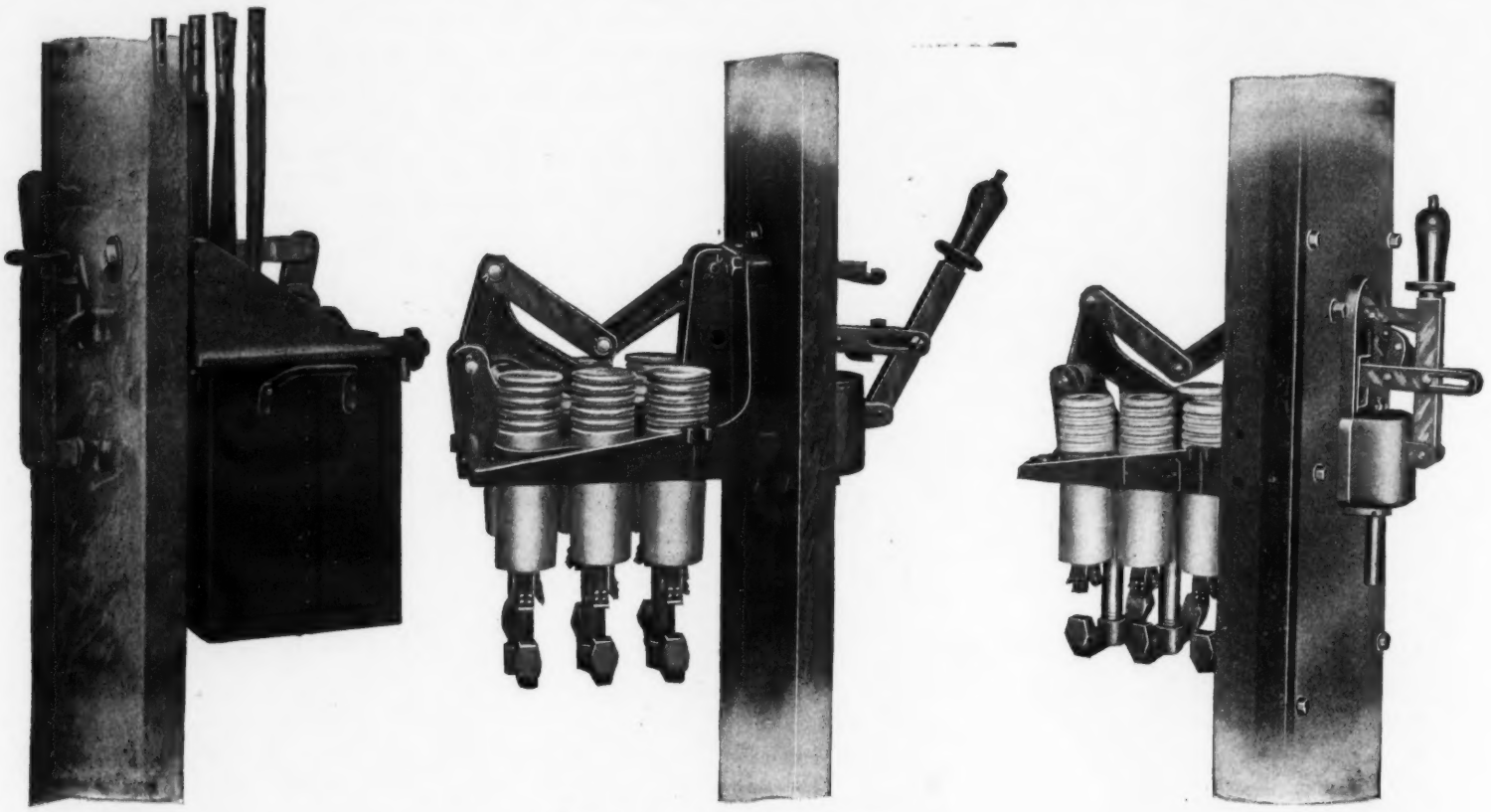
The links and levers forming the switch mechanism proper are so designed that a toggle enables the operator to close the switch with great ease. When the switch is equipped with an automatic trip the topple is set below center, so as to bring more or less pressure upon the tripping link, which, when buckled, allows the switch to open. If the switch is not arranged for an overload release the toggle lever is thrown past the center and the switch is locked in. The oil vessels for the double, triple and four-pole switches are lined and divided into individual compartments by means of wooden barriers.

The oil switch mechanism is connected by a link with the operating lever on the front of the board. When the switch is non-automatic the lever with the escutcheon and fulcrum are the only exposed parts on the front of the panel.

When the switch is electrically tripped the coil and tripping links are located on the front, and in plain view of the operator. A single coil is enclosed in a cast-iron magnet frame forming a part of the escutcheon. The double link connecting the switch mechanism and the operating lever is slotted and held in position by means of a tripping toggle. The core of the solenoid buckles the toggle links and allows the switch to open free from the hand lever. The handle remains in the closed position where it is held by a catch and may be released by means of a thumb push-button. The links projecting out beyond the hand lever indicate that the switch has opened automatically. The tripping link is so designed that it will immediately trip out when contact is first made if the switch is closed on overload or short circuit. This makes it impossible to damage apparatus due to short-circuit conditions.

When this form of oil switch is located at a remote point from the operating stand or switchboard, or placed in fire-proof cells, the operating lever is connected to the switch mechanism through a series of rods and bell cranks. The double, triple and four-pole switches are operated directly from the switch mechanism proper and may be located either straight back from the operating handle or at an angle with the face of the switchboard. The single-pole switches are connected up in groups of two, three and four elements to a common shaft, which is connected in a similar manner to the operating lever. If the operating lever is not located directly in front of a point on the shaft, an angular mechanism will be required.

The remote controlled triple-pole switches are made electrically tripped in the same manner as the switches mounted on the panel. For the single-pole switches the trip coil is mounted at the shaft. When the magnet is energized, the switch is released from the operating mechanism which remains in a closed position. A small switch is provided which closes a lamp circuit, indicating that the oil switch has been electrically tripped. When the switch is opened by hand the lamp does not light and the handle lever indicates that the oil switch is open.



FIGS. 4, 5 AND 6.—OIL SWITCHES.

The 13,000-volt, triple-pole switch, mounted on the panel, is rated to rupture 6,000 kw, three-phase; and the triple-pole or three single-pole remote control switches are rated to rupture 7,000 kw, three-phase. It is not, however, recommended that the switches, when mounted on panels, be used up to the limiting capacities. If the emergency load will exceed 4,000 kw, three-phase, the remote control, triple-pole switch, mounted in the cell, is recommended.

The use of single-pole switches is recommended, for they permit a complete isolation of each phase, practically eliminating the possibility of a short-circuit between the buses in the station. The increased expense of the use of single-pole switches will usually be justified on account of the additional safety when the emergency load can exceed 5,000 kw, three-phase.

The frames of the single-pole switches should not be grounded or connected together by a metal framework or other electrical con-

nection. This type of switch is made in capacities from 600 to 1,300 volts and 100 to 1,200 amp.

The cellular switch shown in Fig. 7 is manufactured single-throw only and is designed for exceptionally heavy work where the kilowatt rupture capacity is greater than that for which the other switches described are suitable.

These switches are motor-operated, thus allowing them to be located at the most convenient point to suit the general station arrangement. The operation of the oil switch is accomplished by a small hand-controlling switch, generally mounted on the panel, with the

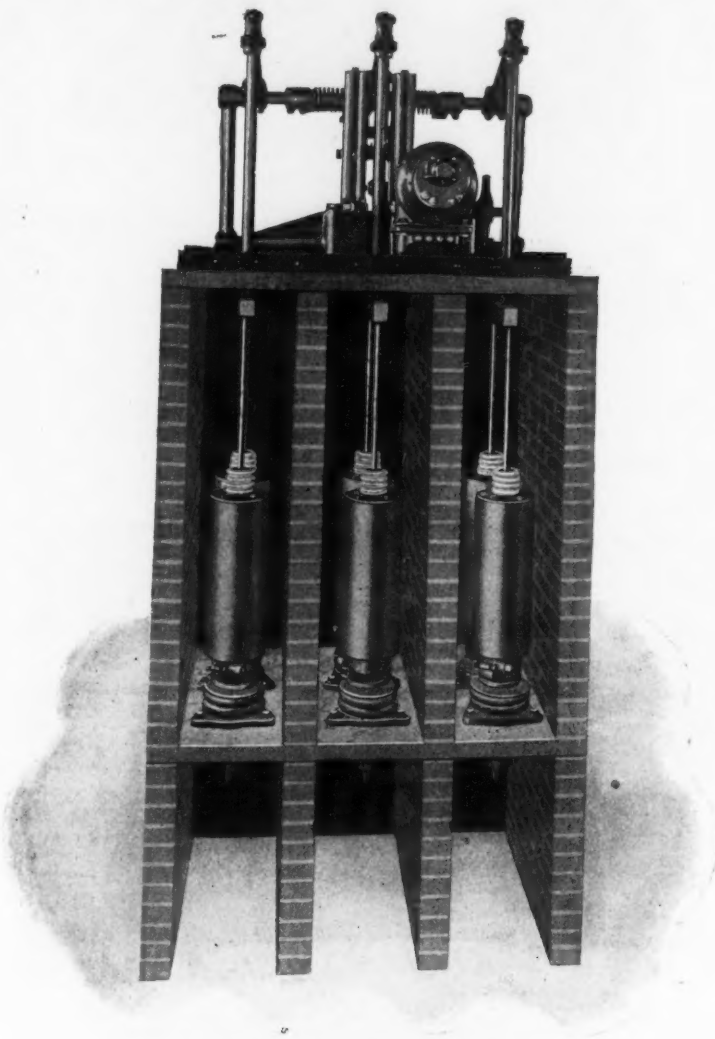


FIG. 7.—CELLULAR SWITCH.

instruments which are in the circuit controlled by the oil switch.

The switch can be made automatic by using a relay, operated by current transformers, which closes the direct current operating motor circuit. The standard voltage for the operating motors is 125, but they may be wound for other voltages when desired. In some cases the switches have been arranged for hand operation, but this method of operation should be considered special. All of this type of switch, however, can be operated by hand with a ratchet wrench, which is specially designed for this purpose and to protect the operator against injury when the crank shaft passes over center.

The switch has six breaks for a triple-pole, each break being in a separate oil receptacle, thus securing a device of great efficiency with a small amount of oil. In addition to this isolation of the breaks, each phase is enclosed in a fire-proof brick compartment, making it impossible for trouble in one phase to be communicated to another. The cells are constructed of brick with top and bottom slabs of slate. The following capacities have been developed: 60,000 volts, 100 amp.; 30,000 volts, 200 amp.; 13,000 volts, 300 amp.; 13,000 volts, 500 amp.; 2,500 volts, 1,000 amp.

This cellular type of switch has been successfully employed in the plants of the Metropolitan and Manhattan Railway Companies, the New York Gas, Light, Heat & Power Company, and the New York Edison Company, of New York City; the Niagara Falls Power Company and the Aurora, Elgin & Chicago Railway Company.

Blake-Knowles Multicurrent Feedwater Heater.

We illustrate herewith a vertical multicurrent feed water heater of Blake-Knowles type introduced by the International Steam Pump Company. In this heater the tubes are arranged in six segmental groups, and the water passes simultaneously through the tubes of each group and successively through the groups. At the top and bottom the tubes terminate in headers, which are divided by partitions which connect adjacent sets. The water entering the water inlet at the side of the heater near the bottom passes up through the first nest of pipes, through the header into the second and down to the lower header into the third, and so on until it issues from the sixth nest through the water outlet. The course of the steam is

MULTICURRENT HEATER, VERTICAL TYPE.

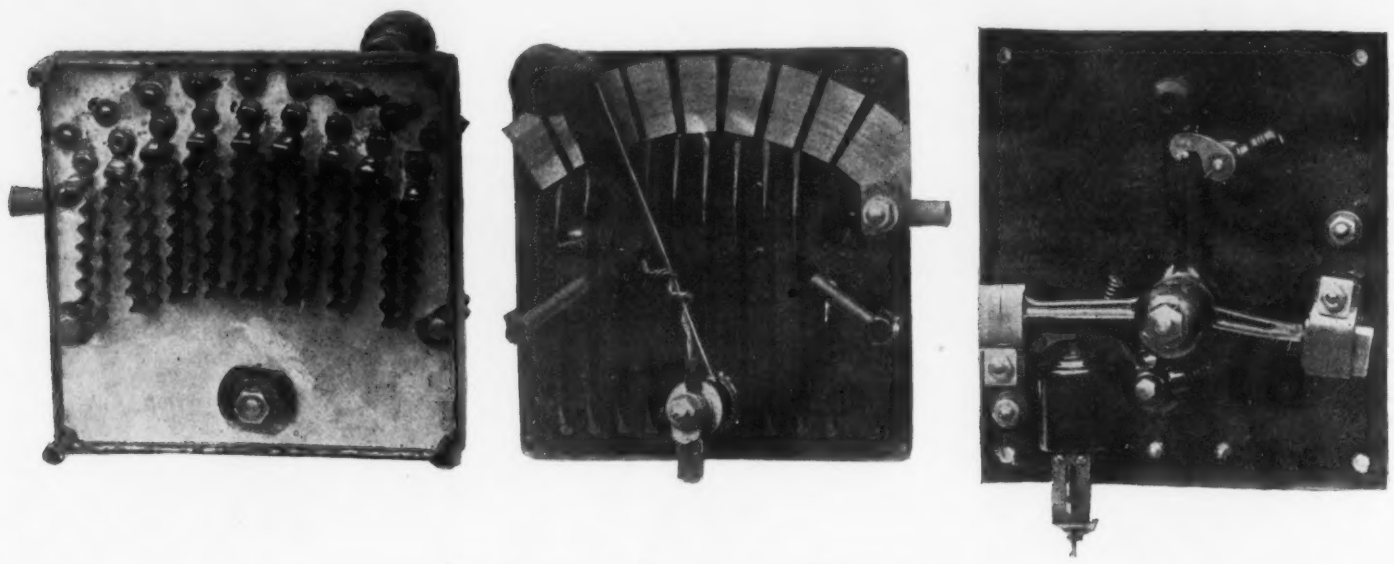
through a path gradually decreasing in cross section. Entering at the steam inlet near the top of the heater it passes down over three sets of the water tubes, the cross section in this chamber being half the total circular area. The diametrical baffle plate extends from the top of the heater nearly to the bottom and causes the steam to pass up through the two adjacent chambers, each having one-sixth of the cross sectional area of the heater. The baffle plates dividing these chambers from the remaining chamber extend from the bottom of the heater nearly to the top, and the steam next passes downward through a cross sectional area equal to one-sixth of the heater and is finally discharged from the steam outlet at the bottom. In this way the path of the steam at each change of direction is cut down one-third and compensates for the reduction in volume due to condensation, with the effect of producing a nearly constant velocity.

The engraving shows an exterior view of a vertical heater of 800 hp size, in which the parts are disposed as just described. A horizontal form is also made, the theory of operation of which is practically the same though the construction is somewhat modified. In both forms the tubes are of composition giving a high efficiency in the absorption of heat, as well as long life. They are easily accessible for cleaning and allow for expansion and contraction, thus making it possible to use copper or brass tubes if the occasion requires. At the ends the tubes are expanded and secured into two heads, one of which is rigid and part of the main casing, while the

other is bolted to a steel plate or diaphragm, the periphery of which is attached to the flange of the heater shell. This arrangement takes care of unequal expansion between the tubes and the shell. Another excellent feature is the absence of stuffing boxes or packings of any kind, doing away with the liability of leakage of feed water. The cross sectional area between the tubes is greater than the area of the exhaust pipe, so as not to cause unnecessary obstruction to the flow of steam, and avoids excessive back pressure. The condensation of the steam accumulating in the steam passages is removed through drip pipes. Blow-offs are also provided to keep the heater clean and free from sediment. Access to the heater is had by removing the heads. The tubes of the vertical heaters can be cleaned from the top, and those of the horizontal heaters from either end. The heaters are made in sizes up to 500 hp.

Rheostatic Combination for Electroplating.

The Ward Leonard Electric Company, of Bronxville, N. Y., has just brought out a rheostat for electroplating work. Fig. 1 shows the back of the electroplating rheostat used for control at the tank and Fig. 2 shows the front view of this rheostat and a special circuit-breaker. The working is as follows: A piece of apparatus which is to be silver-plated—with a certain specified thickness of plate—is suspended in the tank on a balanced beam. Current is turned on and when the exact amount of silver has been deposited, the added weight causes the balanced beam to fall and an auxiliary circuit through the overload coil of the circuit-breaker shown is automatically closed. The opening of the circuit-breaker breaks the main line and the current causing deposition is shut off. The rheostat shown is 11 by 11 by 4 in. in dimensions, has a resistance of .015 ohms, and a normal carrying capacity of 150 amp. It is equipped with self-aligning renewable shoes, renewable segments and a flexible connecting strip between the shoe contact and the line terminal preventing any drop of potential in the lever of the rheostat.

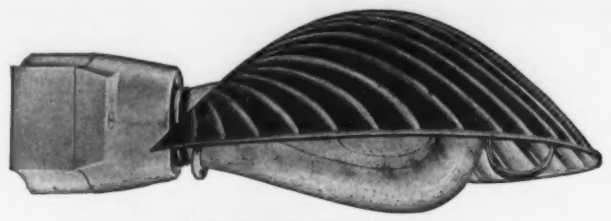


FIGS. 1, 2 AND 3.—ELECTROPLATING RHEOSTAT.

Aluminum Reflectors.

A novel and simple addition to electric lighting appliances and to the resources of the store window illuminator has just been brought out by the progressive firm of R. A. Schoenberg & Co., 1906 Sixth Avenue, New York City. The Sarco parabolic aluminum reflector, which is here illustrated, can be applied to the lamp without regard to socket or receptacle, or fielding receptable, the lamp fitting onto either. This enables a window to be wired with regular fielding receptacles, and by having the Sarco reflector applied direct to the lamp an even better reflecting power is acquired than by using an expensive mirror trough reflector. By its peculiar shell shape it gains at once in reflecting power, as shown by actual photometer test. The lamp setting closer to the reflector's surface reflects considerably more light than it would at a greater distance.

The Sarco parabolic aluminum reflector, owing to its simple and peculiar construction, is also an admirable reflector for the purpose of a desk illuminator, as when the reflector is clamped to the lamp, the bottom of the lamp is nearly submerged by the reflector (or covered, according to the position of the reflector), thus permitting no possibility of the light striking the eye. Being also of aluminum, it has the advantage of being so light in weight and adapts itself readily to the purposes of almost any kind of a desk lamp or portable.



ALUMINUM REFLECTOR.

The finish of the Sarco reflectors is a solid smooth green enamel and the parabolic reflector in position resembles a green sea shell. Owing to its construction, it is possible to use the appliance without screws or clips. One of the chief uses to which the Sarco reflector can be applied is existing cluster lighting, as where a cluster is fitted with a porcelain shade the Parabolic reflector can be clamped direct on the lamp, thus giving the cluster the appearance of an elegant fixture, while at the same time doubling the quantity of the light. The Sarco deep cone reflector brings the polished surface of the reflector so close to the lamp that an actual test with it an 8-cp lamp will give as much light as an ordinary 16-cp light without the reflector. By the simple arrangement in the neck of the deep cone reflector, it can be applied without shade holder wherever desired, as in factory lighting, show rooms, etc.

Engine Builders' Association Council Meeting.

A meeting of the council of the Engine Builders' Association of the United States was held May 10 at the Astor House, New York. Among those present were Mr. C. A. Gates, of the Russell Engine Company, of Massillon, Ohio, who is president of the Association; Mr. J. I. Lyle, manager of the New York offices of the Buffalo Forge Company, the recently appointed secretary; Mr. N. B. Payne, of the Payne Engineering Company, 26 Cortlandt Street, who is chairman of the council; Mr. S. F. Bagg, of the Watertown, N. Y., Engine Company, and Mr. Walter C. Kerr, of the Westinghouse Machine Company.

The meeting was called for the purpose of considering ways and means of procuring more uniform methods in the commercial end of the engine business. Preliminary arrangements were also made regarding the next regular meeting of the Association, which will be held in New York in December. Practically all the members of the Association are identified with firms which make a specialty of building engines for direct connection to generators.

Reaction Brush Holder.

The brush holder is an important part of the great majority of dynamo electric machines and is a feature which in direct-current apparatus has very often been neglected, while other parts of the design were excellent. The type of brush holder shown herewith, and now improved, has been familiar to the public for somewhat over ten years and embodies a number of qualities which have commended it to the users of dynamos and motors. The qualities aimed at in the device are all vital to successful and smooth running, namely, efficiency of contact between brush and holder, freedom or flexibility of the brush in following the commutator contour, absolute parallelism as to plane and motion, slight inertia of the moving parts, a minimum low resistance path, ease and simplicity of handling, and absence of complication in the device.

It will be seen from Fig. 1 herewith that the reaction brush holder includes but six parts. The castings for the body portion and the pressure arm are made from a special composition containing about 90 per cent. of copper and of high conductivity. The contact surface, against which the brush presses in the holder, is subjected to a milling operation that produces a perfectly flat surface. The set-screws have special truncated cone points adapting them equally for a round, flat or v-grooved stud. The spring is simple with no adjusting screws or lock nuts, the pressure on the brush being regulated by changing from one notch to another, as shown in Fig. 2, where, as will be seen, one spring is in one position of the notches

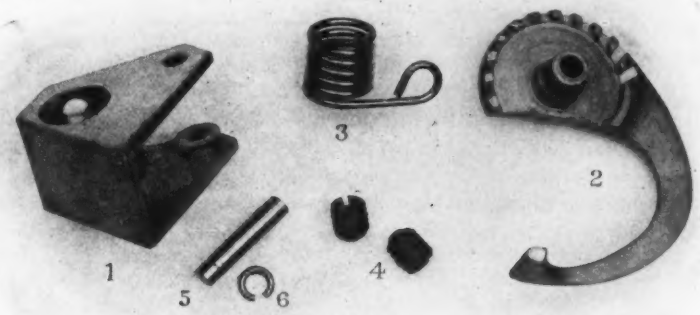


FIG. 1.—PARTS OF BRUSH HOLDER.

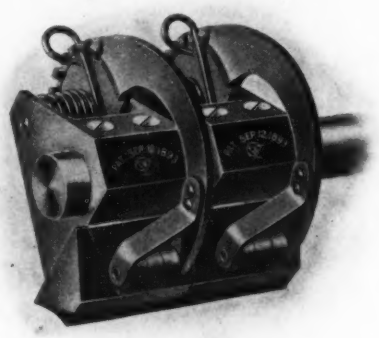


FIG. 2.—SPRINGS.

and another spring is in a different position. The end of the pressure arm is finely serrated, checking any possible tendency that might develop to side movement.

In operation the brush, which is preferably beveled at each end, is placed against the inclined contact plate and is kept always in positive contact therewith by the combined action of the pressure arm at one end and the reaction of the commutator at the other end. Hence, the brush is always maintained in intimate contact with the body of the holder, but so lightly or freely that the condition has been termed a "floating contact," as it leaves the brush entirely free to move away from or toward the commutator. The pressure arm performs the double function of pressing the brush constantly along the smooth contact plate against the commutator and in conjunction with the commutator reaction keeping it always in efficient contact.

The pressure arm is not associated with any box or frame and hence can follow the brush as it wears until it is practically used up. Moreover, the design of the holder permits it to be placed very close to the commutator, furnishing a minimum short path for the current. Owing also to the absence of any box surrounding the brush, all that is necessary to detach it for inspection or cleaning is to lift the pressure arm and simply take the brush away from the contact plate, in place of having to withdraw it from a clamp or box. This can be done even when the machine is in operation. Another feature is that a number of such brushes can be set side by side with no lost space between them, while the use of a flat contact plate without retaining sides makes it possible to use brushes of varying width, embracing the whole range of generator and motor sizes with three or four standard forms of holder. The brush is very quiet in operation and the successive refinements and improvements have made it standard and satisfactory. The device is made by the Baylis Company, of 140 Washington Street, New York City.

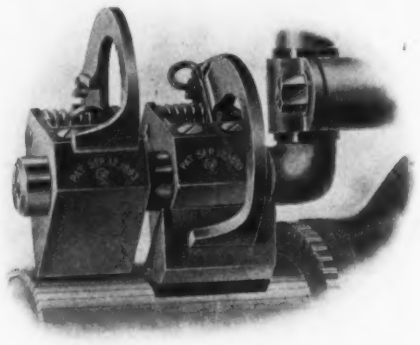


FIG. 3.—BRUSH HOLDER IN POSITION.

"Dreamland" Lighting System of Coney Island.

The Brooklyn Edison Company has installed a 2,200-kw sub-station in the grounds of "Dreamland" for lighting and general power purposes in that new huge Coney Island amusement resort. There are two General Electric units of 1,000 kw each and two of 100 kw each. The power is taken from the union station of the company. It is transmitted at 3,600 volts, three-phase and is transformed at the sub-station to 170 volts alternating current. There are upwards of 150,000 lights, large and small, wired up in the resort. More than 50,000 decorative lights, it is claimed, are used to illuminate a massive tower in the grounds.

The tower is illuminated by thirty-six different circuits. On the apex 2,500 lights are used. The lighting of the tower is controlled by special remote control designed by Mr. C. C. Harley, the chief engineer for the Wonderland Company, which owns "Dreamland," and of which ex-State Senator Reynolds is president. About 600 hp of General Electric motors varying in capacity from 5 hp to 75 hp are used for operating the mechanism in the side shows, chutes, etc. There are more than 300 miles of special slow-burning fire and weather-proof cable used. The size of the cable varies from one to 1,400 cm. The National Conduit & Cable Company secured the contract for the bulk of the work. The switchboard has five panels. There are thirty 1,500-amp. switches which were manufactured by the F. A. La Roche Company.

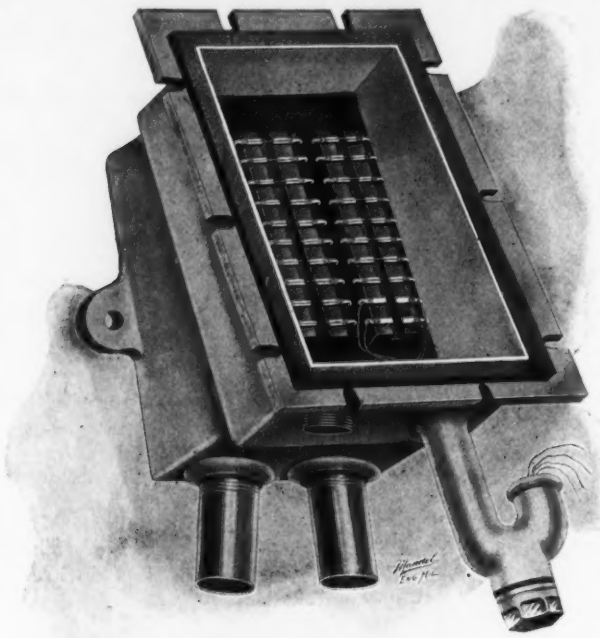
In the event of a break-down in the system, quick connection can be made with the Coney Island plant of the Brooklyn Edison Company, which will enable a 500-lamp control circuit in the grounds to light the resort to that extent.

It is almost needless to add that most of the features of this really wonderful pleasure resort depend largely upon electricity for their attractiveness, either in lighting effects, in spectacular displays or in the movement of mechanism. It is believed that quite a stimulus to such electrical work will be given by the creation of similar shows elsewhere.

Underground Distribution Box.

An excellent form of underground distribution box for telephone, telegraph, fire and police alarm service has been brought out by the Julius Andrae & Sons Co., of Milwaukee, Wis., and is herewith illustrated. It is known as the "Andrae O. K." Its aim is to avoid the usual dead investment in unused wires run from the ground to adjacent pole tops awaiting service, which perhaps never occurs. The box is of cast metal and the front side has a removable cover with brass bolts and screw connections, and is provided with a rubber gasket to keep out the moisture. The bottom of the box has two or more tapped openings for screw-threaded brass nipples, engaged by the cables, and these brass nipples and cables are united by soldering joints.

Inside the box is an insulating base of hard rubber and by means of screws this insulating base is fastened to a ledge projecting from



DISTRIBUTION BOX.

sides and ends of the box. The insulating base is provided with brass contacts mounted on hard rubber ribs, to which wires leading from the cables are attached, being first put through small individual openings, bringing them to the front, so that each connection is in plain view and work can be performed with rapidity.

The insulating compound is poured into the rear of the box—back of diaphragm, through an opening provided on top of the box and when completely filled is closed by a screw plug.

Each box is provided with two goose necks which can be attached whenever necessary under the front of the box through which wires are brought out to the pole or to the fire and police boxes, after which these goose necks are filled with compound. Thus this appliance affords easy and quick access to each conductor in a cable, for connection, test, disconnection, etc., and permits quick adjustment of the system to any emergency.

New Types of Attachment Plugs.

H. T. Paiste & Co., of Philadelphia, have brought out for 1904 a new P-K line of attachment plugs for both brass-capped and porcelain. The new "Pushin" style operates on an entirely new principle, as it is inserted and attached by simply pushing it into the socket, without any twisting of the cord. The two side springs, formed in exact shape to fit the Edison screw shell, hold the plug securely in place, while a third spring at the end completes the circuit. These springs are all of special phosphor-bronze. No. 430 is the standard P-K attachment plug and is made in Edison, T-H and Westinghouse styles. The brass caps are fibre-lined with a fibre bushing already in place in the cord opening. These caps are securely held to the base by two side screws which enter recesses in the porcelain base. All styles of P-K attachment plugs have cord openings

FIG. 1.—BRASS CAP.

FIG. 2.—"PUSHIN."

FIG. 3.—PORCELAIN PLUG.

at least 13/32 in. diameter, so that they are easily wired with reinforced show window cord.

Desk Stand Telephones.

The Connecticut Telephone & Electric Company, of Meriden, Conn., has placed upon the market a new type of desk stand. All the working parts of this stand are entirely enclosed, making it free from handling and absolutely dust-proof. The hook switch is simple

DESK TELEPHONE.

and durable. The construction of this instrument is noteworthy for its high class of manufacture, both for finish and mechanical details. The instrument is equipped with the company's new solid-back transmitter and self-contained receiver, making the instrument one of the most powerful yet placed upon the market.

Big Telephone Consolidation.

Mr. J. G. Splane, president of the Pittsburg and Allegheny Telephone Company, says that within three months a consolidation of all the independent telephone companies between New York and Kansas will be perfected. It is said the enterprise is backed by Standard Oil interests. The headquarters will be in Chicago and the new combination will, it is claimed, have 1,000,000 telephones connected.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—There was a complete lack of speculative interest, and extreme dullness prevailed. The renewed weakness in Steel stocks was the chief feature, common making a new low-record price by selling at 9. Otherwise price movements were unimportant, although there was some firmness in the standard railroad stocks in the face of the reactionary movement in the specialties referred to. The news regarding steel and iron trade conditions was the probable cause of the weakness of the Steel stocks. Some manipulative activity developed in Amalgamated Copper, which hardened slightly, on reports that a compromise with the Heinze interests was possible. The industrial and traction stocks as a class were rather neglected, Metropolitan Street Railway being the only one to display any irregularity. Allis-Chalmers common closed at 6, and preferred at 39½, the latter being a net loss of 1 point. General Electric ranged between 152 and 158, closing at 157, and Westinghouse closed at 155 after having reached 154. Brooklyn Rapid Transit closed at 45¾, a gain of ⅛ point, and Metropolitan Street Railway made a net gain of 2⅛ points, closing at 110¾. Bell Telephone ruled steady throughout the week, the closing price being 126⅜, a net gain of ⅜ point. Western Union lost 1⅛, closing at 88. The curb market was featureless, the general list being a little lower in price in sympathy with the reactionary tendency of the Stock Exchange list. The volume of business was very light. Interborough Rapid Transit lost 1½ points in the week's transactions, closing at 10½. Following are the closing quotations of May 17:

NEW YORK.

	May10	May17		May10	May 17
Allis-Chalmers Co.	6¼	6¼	Electric Vehicle	5⅝	4¾
Allis-Chalmers Co. pfd.	41	40	Electric Vehicle pfd.	9	9
American Tel. & Cable	86	86¼	General Electric	157	154
American Tel. & Tel.	126	123	Hudson River Tel.	..	..
American Dist. Tel	22	22	Metropolitan St. Ry.	109	110
Brooklyn Rapid Transit	45⅝	45⅝	N. Y. & N. J. Tel.	..	..
Commercial Cable	180	180	Marconi Tel.	..	..
Electric Boat	26	26	Western Union Tel.	89	87
Electric Boat pfd	60	60	Westinghouse com.	155	153¼
Electric Lead Reduction	⅝	⅝	Westinghouse pfd.	175	175

BOSTON.

	May10	May17		May10	May 17
American Tel. & Tel	126¼	124	Western Tel. & Tel. pfd.	77	77
Cumberland Telephone	113¼	113¼	Mexican Telephone	1¼	1¼
Edison Elec. Illum.	*235	234	New England Telephone	*122¾	*123
General Electric	157	152	Mass. Elec. Ry.	18½	17½
Western Tel. & Tel	8	8	Mass. Elec. Ry. pfd.	71¼	69½

PHILADELPHIA.

	May10	May17		May10	May 17
American Railways	44	44½	Phila. Traction	96	96
Elec. Storage Battery	56	55	Phila. Electric	5¼	5¼
Elec. Storage Battery pfd.	56	55	Phila. Rapid Trans.	13¼	*13½
Elec. Co. of America.	8	8			

CHICAGO

	May10	May17		May10	May 17
Central Union Tel.	..	..	National Carbon pfd.	101¾	102
Chicago Edison	..	..	Metropolitan Elev. com.	15	15
Chicago City Ry.	155	155	Union Traction	5¼	5¼
Chicago Tel. Co.	..	..	Union Traction pfd.	30	29
National Carbon	28	29			

*Asked

MONEY FOR GOOD INVESTMENTS.—The *Wall Street Journal* states that between January 1, 1904, and May 14, 1904, 135 days, there have been underwritten and sold in the United States securities aggregating over $600,000,000. It has compiled a list showing the principal items that make up this total and the companies that have issued and sold the securities. From this list it has in most cases omitted all issues under $1,000,000, and has not attempted to list securities of small companies or in fact any other securities than those which are well known to the investing public of Wall Street. If the count included all companies the aggregate would probably run over $700,000,000 of securities. From this list it appears that new securities have been sold to the investing public since January 1 at the rate of about $4,450,000 a day. The capitalization of the citizens of the United States has been increased about $8.00 per capita in 135 days. It is impossible, of course, to say how much of the money raised on these securities came from abroad. Probably something over one-sixth of the entire amount was subscribed by foreigners. It says: "The sale of this aggregate of securities in so short a time, coupled with the fact that money can be borrowed to-day in Wall Street at 2 per cent., is suggestive of the tremendous capacity of the United States for the creation and maintenance of legitimate industrial and railroad enterprises." The list includes the following items: General Electric, $3,525,000; Westinghouse, $2,000,000; the following tractions: Metropolitan, N. Y., $2,300,000; Third Avenue, $2,000,000; Central Crosstown, $2,250,000; B. R. T., $4,000,000; Twin City, $3,500,000; Detroit United, $500,000; St. Louis Transit, $8,000,000, and the following telephone securities or notes: Am. Tel. & Tel., $20,000,000; N. Y. & N. J. T. & T., $2,252,000; Bell, of Canada, $2,000,000; K. C. Home Tel., $1,500,000; Keystone Tel., $3,500,000; Northwestern, $1,500,000.

UNITED GAS IMPROVEMENT.—The United Gas Improvement Company shows as follows for the year ending December 31, 1903, and preceding years:

	1903.	1902.	1901.	1900.
Net earnings	$4,027,529	$3,473,643	$2,535,288	$1,714,347
Sale of securities	.....	.....	.....	1,672,424
Total net	$4,027,529	$3,473,643	$2,535,288	$3,386,771
Dividends	2,569,349	2,018,238	1,797,728	1,553,768
Surplus	$1,458,180	$1,455,405	$737,560	$1,833,003

President Dolan says: "It will be noted that the capital stock of this company has been increased to $36,674,955. During 1903 the gas companies in which this company is interested increased their sales 16.6 per cent. in volume over the sales of 1902. The business of the electric light and trolley companies, in which we are interested, increased 11.3 per cent. and 5.3 per cent. respectively. The net profits for the year of $4,027,529 is equivalent to 12.4 per cent. upon the capital actually invested, as the new capital was not paid in until July 1, 1903. Out of these net profits $2,569,349 was paid in dividends and the balance, $1,458,180, invested in the business."

CONSOLIDATED GAS.—The directors of the New York Consolidated Gas Company have adopted a resolution that the capital stock be increased from $80,000,000 par value to $100,000,000 par value. A special meeting of stockholders will be held on June 2 to vote on a proposition to issue $20,000,000 6 per cent. debentures convertible into stock after three years. The stock will be issued to provide for "additional improvements and betterments, the acquisition of additional property, the payment of any indebtedness of the company, whether now existing or hereafter contracted." The stock will be issued to stockholders at par, payable in 3 installments, of 30 per cent., 30 per cent. and 40 per cent., temporary receipts will be issued for each installment, convertible into debentures at the option of the holder.

DIVIDENDS.—The General Electric Company has declared a regular quarterly dividend of $2, payable July 15. The directors of the General Electric Company have voted to offer stockholders of record June 15 the right to subscribe for the new stock at par on the basis of one new share for each ten of the old stock. Subscriptions will be closed July 15 and payments must be made on or before July 20. Subscriptions will be received only for full shares. The directors of the Barney & Smith Car Company have declared the regular quarterly dividend of 2 per cent. on the preferred stock, payable June 1. American Railways Company directors have declared a dividend of 1½ per cent. (75 cents) per share, payable June 15, to stock of record May 31. The Philadelphia Electric Company directors have declared the regular semi-annual dividend of 2½ per cent. (1¾ cents) on the stock $7.50 paid, payable June 15.

INTERNATIONAL STEAM PUMP.—The profits of the International Steam Pump Company for the fiscal year ended March 31, 1904, were, it is officially stated, nearly as large as they were in the preceding fiscal year, when they amounted to $2,113,365, and after deducting interest amounting to $585,709, preferred dividends of $531,000 and common dividends of $590,400, there was a surplus of $506,156. The preferred dividend is cumulative, and the declaration of the usual rate of 1½ per cent. quarterly is expected. With respect to the common stock, however, at the present time, it is not so certain that the rate of 4 per cent. per annum, which has been maintained during the past two years and paid in quarterly installments of 1 per cent. each, will be paid, during the ensuing year.

JERSEY TROLLEYS.—The forthcoming annual report of the New Jersey State Board of Taxation will show Trenton to be the leading trolley centre of the East, with eighteen separate systems and subsidiary lines. It will also show that during the last year of all these lines only one of them paid any dividends. Of the more than sixty such companies in New Jersey only eight of them paid dividends. Their total capital stock is $85,061,880, and they have a total of 980,563 miles of track.

MEXICAN TELEPHONE.—The following is the report, in Mexican currency, of the Mexican Telephone Company, for the year ended February 29, 1904:

	1904.	1903.	Changes.
Telephones in service	4,904	4,478	Inc. 426
Gross	$274,876	$246,368	Inc. $28,508
Net	134,885	111,997	Inc. 12,888
Net revenue U. S. currency	52,523	37,745	Inc. 14,778

Commercial Intelligence.

THE WEEK IN TRADE.—The more favorable weather conditions have stimulated retail trade and farmers have been able to do considerable planting. The improvement in some lines of trade has extended to reorders from jobbers. Reports of industry in general, however, are of slackness, particularly in cotton, woolen and shoe manufacturing. A quieter feeling and easier prices prevail in the iron trade, as a whole. Production is on a large scale, but stocks are not increasing as yet. Sales of 40,000 tons of steel rails, 5,000 tons of bars, and of good quantities of structural material are reported from Chicago. The hardware trade is good, but lumber is not quite up to expectations. A strike of teamsters at Chicago interferes with building activity at that point. In Chicago warmer weather has helped trade in general; in the Northwest farmers are actively employed and this tends to keep down retail trade. On the Pacific coast trade is below the average at San Francisco, while at other places in that section fair business conditions are reported. At the East there is more doing among the jobbers. There was a decrease of 5 per cent. in railway earnings in April as compared with the corresponding month last year. Copper prices are still firm, but the demand for consumption is dull. Quotations are unchanged, at 13⅜c. to 13⅝c. for Lake, 13⅛c, to 13¼c. for electrolytic, and 12⅞c. to 13⅛c. for casting stock. The exports for the month, so far, have been light, amounting to 4,300 tons. The business failures during the week ending May 12 numbered 201, as reported by *Bradstreet's*, against 176 the previous week and 182 the corresponding week in 1903.

SHANGHAI MUNICIPAL TRAMWAYS.—The firm of Fearon, Daniel & Co., of China, and of 90-96 Wall St., New York City, are advertising again for bids on the tramway concession for the Shanghai Municipal Council. It may be remembered that this was originally brought to the attention of the public as far back as 1898, when a contract was entered into between the municipality and the Brush Electrical Engineering Company of England. Due probably to the serious Boxer troubles which broke out in the Chinese Empire, the Brush Company did not proceed with the contract, so that the matter is again open for competition, and should receive the attention of American engineers. The firm in question have the full details of the concession, the main point of which is the deposit of $25,000 upon signing the contract. The road proposed is a fairly extensive one, comprising in the five specific sections, about 5¾ miles of double track, and 10¾ miles of single track to be equipped with span wire construction for double track, bracket for the single, and with iron or steel poles. The conditions laid down in the original tramway agreement must be complied with, but the agents state that a fair and reasonable proposal will have favorable attention on the part of the Municipal Council. The company putting in the road is permitted to collect from each first-class passenger 6 cents for a maximum distance of 1½ miles, and from second-class passengers 2½ cents. The company is to pay the council a yearly rental of $500 per mile of single track, and $750 per mile of double track. These and many other details are given in the papers in the hands of the firm named.

MOVING PLATFORMS.—It is stated that as an alternative to the proposition of the New York City Railway to give free transfers between their surface lines and the next rapid transit subway, if built by the Metropolitan, the Interborough Rapid Transit Company has formed a combination with the Schmidt & Gallatin moving platform syndicate to interchange transfers from the elevated or subway lines to a platform subway under Thirty-fourth Street. This proposition was laid before the Rapid Transit Commission last week by F. Kinsbury Curtis, lawyer for the syndicate. According to the plan of the combination, the Thirty-fourth Street crosstown connection from Ninth to Second Avenues, if made possible of construction, will be followed by like moving platform subways through Grand, Twenty-third, Fourteenth and Fifty-ninth Streets, to connect the elevated and subway lines. The proposition of Mr. Curtis covers the original route suggested by the moving platform people—over the Williamsburg Bridge, with a loop to the Battery—and a second route across Thirty-fourth Street.

EQUIPMENT FOR GRAND HOTEL EXTENSION.—Contracts have just been awarded through James Robert Moore, consulting engineer, 156 Fifth Avenue, New York, for the electrical equipment to be installed in the extension of the Grand Hotel, Thirty-fifth Street. The Construction Realty Company, 112 West Forty-second Street, has the contract for the construction and equipment of the building. The Buffalo Forge Company, through its New York City office, 39-41 Cortlandt Street, of which J. J. Lyle is manager, secured the engine contract. There will be three 90-hp and two 40-hp horizontal centre crank direct-connected to 50-kw. and 25 kw. generators respectively. The generators will be built by the Crocker-Wheeler Company. The equipment is intended for both light and power use.

ELECTRICAL SUPPLIES, ETC., FOR VENEZUELA.—The La Guayra Electric Light Company, of La Guayra, Venezuela, is placing considerable orders for electrical supplies, etc., through the export commission house of Kates & Bok, Orient Building. Mr. Carlos G. Palacios, chief engineer of the Caracas Electric Light & Power Company, is consulting engineer of the La Guayra Company. Mr. Palacios was recently on an extended visit here. At one time he was associated with the United States Electric Company, of Newark, N. J., and to his efforts is largely due the steadily increasing influx of Yankee electrical equipment, etc., into Venezuela.

CROSSLEY GAS ENGINE FOR LEXINGTON PLANT.—The Lexington (Ky.) Steel Ry. Co. has placed a contract with the Power & Mining Machinery Company (formerly Loomis-Pettibone Gas Machinery Company, of New York, successor to the Holthoff Machinery Company, of Milwaukee, Wis.), 52-54 William Street, New York, for a 500-hp Crossley gas engine to be direct-connected to a direct current, 550-volt generator of 300-kw capacity. The equipment will be installed in the existing steam power plant of the Lexington concern, whose capacity is about 2000-hp.

ELECTRIC CRANES FOR CANADIAN LOCOMOTIVE SHOPS.—Manning, Maxwell & Moore, 85 Liberty Street, have been allotted a contract for three electric traveling cranes for the Locomotive Machine Works, Montreal, which are now controlled by the American Locomotive Company. There will be two cranes of 10 tons' capacity each and one of 15 tons. The cranes will be built by the Shaw Electric Crane Company, of Muskegon, Mich.

ELECTRIC TRACTION OF MAZATLAN, MEXICO.—A concession has been granted to Janier Maxenim for the construction of an electric traction system in Mazatlan, a flourishing seaport town located in the State of Sinaloa, Pacific Coast, Mexico. There is at present a two-mile mule line. The new system will be about five miles long. Mr. Maxenim is expected to arrive here very shortly to place contracts for equipment.

ADIRONDACK ACTIVITIES.—The Paul Smith Hotel Company, Paul Smith's, Adirondacks, N. Y., will develop its water power on the Saranac River at Franklin Falls, N. Y., and build a power plant, from which will run transmission lines to Paul Smith's, Saranac Lake and Lake Placid, to operate an electric railway between the points named. The work will be done by the day, by its own men. Mr. A. C. Rice, State Mutual Buildings, Worcester, Mass., is the consulting engineer.

HOTEL TELEPHONES.—The hotels in Washington are "catching on" to the idea of a telephone in every room. The Chesapeake & Potomac Telephone Company, licensee for the Bell system, has secured contracts recently for the following hotels, all in Washington: Hotel Raleigh, 300 stations; Cairo Hotel, 80 stations; Hotel Rochambeau, 85 stations. The work of installing these telephones will begin at once.

EQUIPMENT FOR ASTOR ESTATE.—Col. John Jacob Astor has contracted through Mr. C. O. Mailloux, consulting engineer, for considerable electrical equipment to be installed for light and power purposes on his Rhinebeck estate. The De Laval Steam Turbine Company secured a contract for steam turbines. The Electric Storage Battery Company, of Philadelphia, has also been allotted a good-sized contract.

EXPORT TRADE.—The exports for the ten months including April amount to $1,277,859,235 or $54,000,000 more than last year; and the imports to $829,002,914 or about $35,000,000 less than last year. The excess of exports for the ten months is $448,856,321. For the month of April merchandise exports were $109,995,160, and imports $83,496,521, an export excess of $26,498,639.

ALLIS-CHALMERS-BULLOCK.—The Canadian business of the Allis-Chalmers Company, which recently acquired the Bullock Electric Manufacturing Company, of Cincinnati, will hereafter be conducted by a new organization bearing the name Allis-Chalmers-Bullock, Ltd. The works and principal offices of this important new Canadian company are in Montreal.

LIGHTING EQUIPMENT FOR HOTEL AMERICA.—The American Engine Company, of Bound Brook, N. J., has secured a third contract for lighting equipment to be installed in the Hotel America. Fifteenth Street and Union Square, New York. The outfit will include a 60-hp American Ball single engine to be direct-connected to a 35-kw. generator.

GORHAM MFG. COMPANY'S NEW PLANT.—Mr. C. O. Mailloux, 76 William Street, is consulting engineer for the electric plant which is to be installed in the new premises of the Gorham Manufacturing Company, silversmiths, at Thirty-sixth Street and Fifth Avenue, New York.

General News.

THE TELEPHONE.

JUNEAU, ALASKA.—All the mines in this vicinity within a radius of 40 miles will be connected by telephone during this summer. President Webster of the Juneau Light & Power Company is interested in the project.

LOS ANGELES, CAL.—The Home Telephone Company has decided to extend its system to San Diego in the near future. Material has been purchased and is now being delivered at San Diego.

LOS ANGELES, CAL.—The San Fernando Valley and Home Telephone Company is installing a system with a central office at Burbank, and lines will run to Toluca, Glendale, Eagle Rock and other suburban towns.

BOULDER, COL.—The city government of Boulder, Col., has granted an independent telephone franchise to Charles C. Townsend, of Greeley, Col., vice-president of the Morgan County Independent Telephone Company of that State. Mr. Townsend states that he and his associates intend to build a $100,000 plant in Boulder as soon as the work can be done, and that the rates will be $1 per month for residence telephones and $2 for business telephones on absolutely single party lines. It is understood that two per cent. of the gross receipts will be paid to the city of Boulder.

MOSCOW, IDA.—The Interstate Co-operative Telephone Company, of Moscow, has been absorbed by the Lookout Telephone Company of Lewiston, Ida.

LIBERTY CENTER, IND.—The Liberty Center Telephone Company is establishing an exchange and service in this town and county.

BLOOMFIELD, IND.—The New Home Telephone Company, of this city, will issue preferred stock to the amount of $100,000, to be disposed of for the purpose of securing funds to extend the lines and improve the plant.

STENDAL, IND.—The Stendal Home Telephone Company, has organized and incorporated. The capital stock is $10,000. John W. Stilwell, F. W. H. Schumaker, Wm. H. Eibert are among the incorporators.

EVANSVILLE, IND.—The Cooperative Telephone Company which advanced its rates a few weeks ago, was forced to readjust them on account of the wholesale "ordering out" of its telephones by the patrons. The old rates will be restored.

TERRE HAUTE, IND.—The stockholders of the Citizens Telephone Company have decided to install 32,000 feet of new cable and two sections will be added to the main switchboard at the central exchange. Another section will be added to the board at the North exchange. The cost of these improvements will be about $26,000.

ELKHART, IND.—The Central Union Telephone Company has been granted permission to lay conduits on all the streets asked except Franklin. It will expend about $75,000 in this city, greatly improving its present service and adding new equipment. It is said that the company will also improve and extend its plant to Goshen and between Goshen and Elkhart, the change to cost about $50,000.

EVANSVILLE, IND.—The Board of Public Works has granted a 30-year franchise to the Citizens' Telephone Company. The rental for business telephones shall not be more than $4 a month on full copper metallic circuit and $2 a month for residence instruments on metallic circuits. The Evansville Home Telephone Company is also seeking a franchise in this city. It is said that J. O. Parker, a banker, and other influential business men are back of the new company. In many respects the franchise submitted is the same as the one passed by the board to the Citizens' Telephone Company. The rules are to be $3.50 for business, $2 for residence and $1 for party line service. The Citizens Telephone Company has filed articles of incorporation. The capital stock is $100,000. A. F. Karges, M. L. Johnson, M. S. Sontag and others are the incorporators.

WAUKON, IA.—The Paint Creek Farmers' Telephone Company has been incorporated with a capital stock of $15,000. Wm. Rood is president.

OTTUMWA, IA.—The Iowa Telephone Company contemplates building a new exchange in this city, plans for which are being prepared by architect G. M. Kerns.

SUMNER, IA.—The stockholders of the Sumner Telephone Company have voted to sell, at public sale, its property, consisting of toll lines, exchanges, instruments, franchies, etc. The sale will take place at Sumner on May 25.

ALBANY, IA.—At the annual meeting of the stockholders of the Albany Home Telephone Company the following-named officers were elected: Howard Hendrickson, president; Irving H. Griswold, vice-president; George C. Lee, Jr., treasurer, and H. J. Price, Jr., secretary. The annual report shows an increase of 1159 in the number of telephones during the year with about 200 contracts on file waiting for installation. After operating for 15 months the company has earned 9 per cent. on the stock, after paying all expenses and fixed charges.

BOWLING GREEN, KY.—A company has been formed at Woodbourne, this county, to establish an independent telephone service at that place.

DANVILLE, KY.—The citizens of Junction City have organized a company at that place for the purpose of installing a telephone exchange. Dr. J. R. Steele was elected president.

CENTER LINCOLNVILLE, ME.—The Center Lincolnville Telephone Company has been organized to establish an exchange at this place. It has a capital of $1500. The officers are: President, J. S. Mullin; treasurer, W. D. Ross, both of Center Lincolnville.

BANGOR, ME.—The People's Telephone Company has been organized at Mercer for the purpose of building a line from New Sharon to Norridgewock. The capital stock is $27,000, and the officers are: President, C. K. Allen; treasurer, N. E. True, both of Mercer.

MECHANICSVILLE, MD.—The Southern Maryland Telephone Company has been organized with J. F. Coad as president.

ASHLAND, NEB.—The Ashland Telephone Company has filed articles of incorporation, with the Secretary of State, the capital stock being $50,000. It is the intention of this company to re-organize the old independent company at Ashland and to make a number of improvements in the service. The incorporators are Herbert H. Harndon, president; W. R. Shankland, secretary, and E. J. Rose, treasurer.

BATH, N. Y.—A new telephone company has been organized here with Isaac Rising as president.

COOPERSTOWN, N. Y.—The Cooperstown Telephone Company has increased its capital stock from $7000 to $10,000.

NORTH COLLINS, N. Y.—The North Collins Telephone Company has been incorporated with a capital stock of $5000. The directors are W. M. Ward, D. A. Dillingham and H. G. Parker, of North Collins.

WALTON, N. Y.—The Delevan Telephone Company, of Walton, has been incorporated with a capital stock of $3000. The directors are Grant Wilson, I. L. Brayman, Walton, and Thomas Carey, of Hancock.

BUCYRUS, OHIO.—The Bucyrus Telephone Company has increased its capital stock from $30,000 to $65,000. Mr. John A. Chesney is president and J. C. F. Hull, secretary.

CLEVELAND, OHIO.—The Cuyahoga Telephone Company has been ordered by the Board of Public Service to take down two miles of poles in the center of the city and place the wires underground.

ASHTABULA, OHIO.—At the annual meeting of the Ashtabula Telephone Company the following officers were elected: President, P. C. Remick; vice-president, W. R. Flower; secretary, S. W. Crosby; treasurer, D. B. Seymour. The company has added over 200 new telephones to its service during the past year.

MT. VERNON, OHIO.—At the annual meeting of the Mt. Vernon Telephone Company it was decided to re-incorporate the company under the laws of Ohio and to increase the capital stock from $100,000 to $150,000. The original company was incorporated under the laws of West Virginia. The company controls exchanges in Mt. Vernon, Fredericktown, Gambier, Centerburg, Twin City and Brandon, representing a total of 1603 telephones. The following-named gentlemen were elected directors: Frank L. Beam, Harry C. Devin, W. P. Bogardus, P. S. Kelser, E. O. Arnold, B. D. Herron, R. G. McClelland, H. G. Beam and J. W. Kelser.

CROWE, ORE.—The Crowe Telephone Company has been incorporated with a capital stock of $1000 to build a line between Crowe and Elmira, Ore.

ALBANY, ORE.—An independent telephone exchange is to be installed here. Messrs. W. R. Bilyue, L. C. Stratton, G. A. McCart and others have been appointed a committee to take action in the matter.

EUGENE, ORE.—The R. B. Electric & Manufacturing Company, of Kansas City, has asked the city council through W. D. DeVarney for a telephone franchise. Mr. DeVarney has opened an office at Portland, Ore.

PITTSBURG, PA.—The Wheeling & Pittsburg Telephone Company is to extend its lines.

PHOENIXVILLE, PA.—The Mutual Telephone Company has just formed here with R. K. Allsbach as president.

CANTON, S. D.—The Mutual Telephone Company has been incorporated with a capital stock of $20,000.

PIERRE, S. D.—The Eldon Home Telephone Company has been incorporated with a capital stock of $50,000.

LINWOOD, TENN.—The Linwood Telephone Company has been incorporated by H. D. Beadle, W. W. Young and others. It is capitalized at $1000.

EL PASO, TEX.—The contract for the construction of the new telephone exchange building for the Southwestern Telegraph & Telephone Company in this city has been let to C. W. Mackenzie for $11,000.

EL PASO, TEX.—The city council of El Paso has granted a telephone franchise to R. V. Bowden, attorney for the Southern Independent Telephone Company. The scale of rates provides that the minimum charge shall be $3 per month for business telephones and $2.17 per month for residence. This rate is to be charged when the company has from 1000 to 1500 telephones in use. The maximum rate shall be $4.70 for business and $3 for residence, to be charged when the number of telephones in use is between 4000 and 4500.

WHATCOM, WASH.—The Sunset Telephone Company will erect an exchange and general office building here.

TRINIDAD, WASH.—The Farmers' Telephone Company and the Bell Telephone Company offer to build a line from Trinidad to Wenatchee and Euphrata if $600 worth of stock is taken.

SPOKANE, WASH.—The Cheney & Spangle Mutual Telephone Company has been granted a franchise by the Spokane County Commissioners. The officers of the company are M. Ludwig, president; E. Thompson, secretary, and Saul Lind, treasurer.

SPOKANE, WASH.—The city council has granted to the Interstate Telephone Company a franchise to operate its system in this city. This will give Spokane patrons connection with numerous cities in what is known as the Panhandle district. The company has commenced the construction of a line from Spokane to Harrison, Ida. It will be 200 miles in length.

UTICA, WIS.—The Utica Telephone Company has filed articles of incorporation with a capital stock of $5000. The incorporators are Jasper Pickett, president, and Albert Parks, Robert Mackie and W. E. Munsil.

MINERAL POINT, WIS.—The Duke's Prairie Telephone Company, of Mineral Point, has been incorporated with a capital stock of $5000. The names of the incorporators are Charles Collicutt, James M. Pile, Joseph Whitford and William Harford.

ELECTRIC LIGHT AND POWER.

BIRMINGHAM, ALA.—Saml. H. Lea, Chief Engineer, 305 Title Guarantee Building, this city, states that a power plant is proposed, but plans are not matured concerning size and details of construction.

ANNISTON, ALA.—The Clear Creek Mining Company has placed a contract with the Crocker-Wheeler Company for a 100-kw engine-type generator to be direct-connected to a new Ball & Wood engine in the company's plant at Arbacoochee. The new machinery will represent an outlay of $60,000.

CLARKESVILLE, ARK.—Col. E. T. McConnell has secured a franchise for lighting this city by electricity.

FAYETTEVILLE, ARK.—Bids are wanted for a 2-phase 120-kw alternator to be operated either by steam turbine or direct connected engine. It is understood that a day circuit will be maintained both for light and power. Other improvements are also being considered . F. W. Fratt, owner, 1001 North Broadway, Oklahoma City, O. T.

TEMPE, ARIZ.—The Tempe Pumping Company has been organized to develop water power for the production of electrical energy. The electric power will be transmitted to five sub-stations and will also be used for industrial purposes and lighting. Irrigation will also form a part of the company's work.

ALAMEDA, CAL.—A resolution has been passed by the council authorizing the electric light committee to install a day service in the municipal electric light works for power.

QUINCY, CAL.—The Quincy Water & Power Company has been incorporated by J. D. Goodwin with a capital of $50,000. It is the intention of the company to improve the water works and to install an electric power plant.

BUENA VISTA, COL.—Articles of incorporation of the Chaffee County Electric Line, Power & Railway Company have been filed with the Secretary of State by Senator Wm. E. Mason, of Illinois, and associates. The company contemplates the erection of several water power stations at various points in the county.

NORFOLK, CONN.—The town authorities are considering the question of installing a new electric light plant.

SAND POINT, IDA.—The Sand Point Electric Company is now operating the city arc lights on the multiple system, but expects to install the series alternating current system during the coming fall. The company will also install a new 150-hp engine.

TABLE GROVE, ILL.—The citizens have voted to issue $4000 bonds to take over the electric light plant or install a new plant.

PERU, IND.—The Indiana Hydraulic Company is about ready to receive bids for the construction of a dam, electric power plant and electric railway between Vincennes and West Baden. J. Herff is president.

GREENSBURG, IND.—The Greensburg Gas Light Company has changed its name to Greensburg Gas & Electric Company and increased its capital stock $30,000. The purpose is to equip a plant and furnish electric light and power to the citizens of Greensburg.

MARION, IA.—The Marion Light, Heat & Power Company proposes to install new generators for street lights.

NEW ORLEANS, LA.—Bids will be received June 11 by Mordecai T. Endicott, Chief of Bureau Yards and Docks, Navy Department, Washington, D. C., for installing boilers, turbines, condensers, generators, etc., at the New Orleans Naval Station.

PITTSFIELD, ME.—The plant of the Pittsfield Electric Light & Power Company was completely destroyed by fire May 3. The loss was partially covered by insurance. A temporary plant is to be constructed.

CUMBERLAND, MD.—The following-named gentlemen have been elected officers of the Piedmont Electric Light & Power Company: President, H. B. Carroll; vice-president, Timothy Kenny; secretary, Norris Bruce; and treasurer, W. W. Shultice.

HOOSICK FALLS, MASS.—At the annual meeting of the Hoosick Falls Electric Light Company the following-named officers were elected: Frank H. Viele, president; D. L. Hall, vice-president; W. H. Tylee, secretary and treasurer, and Ralph D. Smith, general manager.

BOYNE CITY, MICH.—The Boyne City Electric Company proposes to develop a water power of 300-hp and will install a three-phase generator.

GRAND LEDGE, MICH.—Engineer H. A. Sprague, of Corunna, is stated to be interested in the Grand River Power Company, which is said to have secured an option on land along the river to be used for electrical purposes.

OTSEGO, MICH.—The Kalamazoo River recently formed a new channel around the Southern end of the big dam at the power plant of the Kalamazoo River Electric Company, depriving the plant of its supply of water. Most of the cities between Kalamazoo and Jackson, as well as the Jackson, Battle Creek Interurban road, depend upon this plant for power, and business was suspended temporarily while the Otsego dam was being disconnected from the others. The company has sufficient power to meet all demands. It will take about ten days to repair the damage.

FORT SNELLING, MINN.—It is proposed to increase the boiler, engine and generator capacity in the electric light plant at this post. Information can be obtained by addressing the quarter-master's department, Fort Snelling.

HANNIBAL, MO.—The Board of Public Works has closed several contracts for machinery, etc., for the new $100,000 municipal electric light plant.

PORTSMOUTH, N. H.—The board of tax assessors has decided to assess taxes upon the entire light and power plant of the Rockingham County Electric Light & Power Company of this city. This is the largest plant in the State and when it was built the city voted to exempt all new work of the company from taxation for a period of ten years. Since then the plant has been developed at a cost of $500,000. The supreme court decided that all votes of cities and towns exempting light and power plants from taxation are illegal and void.

NEWARK, N. J.—The following-named gentlemen have been elected officers of the Woodbourne Electric Light, Heat & Power Company of Sussex Borough: President, Charles A. Wilson: vice-president, C. H. Chrisman; secretary, A. W. Deldell; treasurer, Dr. H. D. Van Gassbeek.

SALISBURY, N. C.—The Salisbury Gas & Electric Light Company proposes to build a street railway five miles in length, install two new boilers, and new generators.

SANFORD, N. C.—The Sanford Electric Light & Power Company is extending its lines to Jonesboro, a distance of two miles, and will install about 500 additional lamps.

KENTVILLE, N. C.—The Kentville Electric Lighting & Power Company will probably install a small steam and electric unit for late night service. Judge Chipman, of Kent, is president of the company.

LEXINGTON, N. C.—The plant of the Lexington Water & Light Company was destroyed by fire on the night of April 30. Mr. F. W. Siebert is manager and G. W. Montcastle is president. The plant will be rebuilt.

DICKENSON, N. D.—Hughes & Dieters, proprietors of the electric light plant here, will install a new tubular boiler some time during the coming summer.

CINCINNATI, OHIO.—A number of local interests are forming a company to undertake the work of utilizing for power and commercial purposes the Ohio River from Pittsburg to Cairo. The object is to construct a system of reservoirs at the head waters of all the rivers and streams emptying into the Ohio along its entire length, thereby controlling the waters of the Ohio River. Another meeting of the projectors is to be held soon to decide whether the government shall be requested to conduct the enterprise, or whether it shall be carried out by private capital.

STAYTON, ORE.—The Stayton Electric Light Company expects to install a 250-volt booster in its plant here.

ROSEBURG, ORE.—The Umpqua Water, Light & Power Company was organized March 1 last by consolidating the Douglass Electric & Water Company and the Roseburg Water & Light Company. The capitalization of the company is $50,000. The officers are: President, Fred J. Blakeley; secretary, Dexter Rice; treasurer and manager, T. R. Sheridan; superintendent, F. H. Farrer.

BROOKSVILLE, PA.—The Solar Electric Company contemplates installing an additional dynamo and one 150-hp engine.

TARENTUM, PA.—Some improvements are contemplated in the municipal electric light plant at this place at a cost of between $10,000 and $12,000. The plant will be operated on the meter basis.

JEFFERSON CITY, TENN.—The Jefferson City Electric Company proposes to add some steam equipment to its plant.

CARTHAGE, TEX.—Mr. John C. Whitney, owner of the electric light plant here, proposes to give the plant a general overhauling and will probably install a more economical prime mover.

FOUNTAIN GREEN, UTAH.—The Big Springs Electric Company is considering the advisability of extending its electric lighting service to Ephraim, 12 miles from here.

LOGAN, UTAH.—Garff & Sons are making negotiations with the city council to establish and equip an electric lighting plant here, which is to be sold to the city after four years.

BURLINGTON, VT.—Bonds for $58,000 will be issued for a municipal electric light plant here. The city attorney is now looking into the legal questions connected with such an enterprise.

RUTLAND, VT.—The Rutland City Electric Company recently installed a new modern switchboard at its station. The board contains 11 panels of Vermont blue marble, each panel being 7 ft. high.

TAZEWELL, VA.—The Tazewell Electric Light & Power Company has been incorporated at Tazewell with a capital stock of $15,000. Joseph S. Moss is president.

HOOSACK, WASH.—The Washington Mining & Development Company in the Mt. Baker District is preparing to install an electric plant.

NORTHPORT, WASH.—The Northport Electric Company's plant was destroyed by fire May 4, entailing a loss of $4000. Mr. Robt. Morrell is manager and owner.

GLIDDEN, WIS.—There is an opening for an electric light plant in this place.

NEENAH, WIS.—In January last the city council awarded to the Fox River Valley Gas & Electric Company a franchise to light the city for a term of 20 years. Later this contract was annulled, and a similar one was let to the Wisconsin Light, Heat & Power Company, of which John I. Beggs, of Milwaukee, is the head. The Fox River Company has entered court to contest the annullment of its contract, and the Beggs company has agreed to indemnify the city against any damages or costs that may arise from the legal action.

NELSON CITY, B. C.—Bonds have been issued for the erection and equipment of a 3000-hp plant for power and lighting purposes.

BATHURST, N. B.—A contract was signed at Bathurst for putting in an electric light plant for lighting the town and village. The plant will be run by water power, which will be obtained from the Tamagouche River, two and one-half miles from Bathurst.

ACTON, ONT.—The electric light plant here, which is operated by the town, proposes to install a day power service.

CARLTON PLACE, ONT.—The Carlton Place Electric Light Company proposes to increase the capacity of its plant during the present season. Messrs. H. Brown & Sons are the proprietors.

THE ELECTRIC RAILWAY.

PRESCOTT, ARIZ.—Frank Wright, manager of the Prescott electric lighting system, of the local telephone system and of the new electric street railway, has a plan for penetrating the nearby mining districts with electric railways for hauling freight and ores.

MT. HERSEY, ARK.—The North Arkansas Electric Railway Company has filed articles of incorporation. The capital stock is $150,000, of which $30,000 has been subscribed. The officers are Griff Glover, of Bloomfield, Mo., president; E. K. Eby, of Jasper, Ark., vice-president; S. J. Norman, of Jasper, Ark., secretary and treasurer.

VISALIA, CAL.—The Visalia Electric Railway Company has been incorporated with a capital stock of $1,000,000 to build a 24-mile electric railway to run easterly from Visalia to Exeter, Lemon Cove and Lime Kiln Point. The directors are W. H. Hammond, Ben M. Maddox, Susman Mitchell, C. J. Giddings, all of this city, and Harold Wheeler, of New York.

DENVER, COL.—The Denver-Boulder Interurban Railway Company has been incorporated with a capital stock of $1,000,000. The directors of the road are: Ex-Mayor Henry V. Johnson, of Denver; Charles F. Potter, Judge Sterling B. Toney, of Denver; John R. McKinnie and L. L. Aitken, of Colorado Springs, and John H. Simpson and Percival Moore, the latter of Louisville, Ky. The company will be bonded for $500,000.

DANIELSON, CONN.—The Worcester & Eastern Railway Company, which is controlled by the New York, New Haven & Hartford Railroad, has made application to the Superior Court for New Haven County for a change of its name to "The Consolidated Railway Company."

GRANITE CITY, ILL.—At the annual meeting of the Venice, Madison & Granite City Railway Company, by unanimous vote the corporation was dissolved and the charter surrendered. The company sold out to the Granite City & St. Louis Railway Company, in which Governor D. R. Francis, of Missouri; Fred E. Allen and E. J. Spencer are the principal stockholders.

GENEVA, IND.—The Geneva Traction Company has filed articles of incorporation. The company is capitalized at $20,000. The purpose of the company is to construct an electric railway in Geneva and to Montpelier, Ind., and one also to Celina, Ohio, and will furnish electric light and power to various people and manufactories along the route. The company's office will be at Geneva and the concern will be managed by a board of seven directors, including A. G. Briggs, Charles Parks, E. F. Welch, J. H. Hardison, S. W. Hale, D. M. Shirley and W. J. Huter.

FOREST CITY, IA.—D. B. Lyons, of Des Moines, and an engineer, will survey for the proposed electric railway from Forest City to Cresco. It is now proposed to build to the Mississippi River, and a company with $1,000,000 capital will be organized.

LOUISVILLE, KY.—The Lebanon & Columbia Electric Railway has incorporated with a capital of $1,000,000. The line will be 42 miles in length. The incorporators are prominent business men of Lebanon, and W. K. Azbil, of Lebanon, is president. Arrangements for financing the project are said to have been made.

HENDERSON, KY.—The Henderson Street Railway, in which Joseph E. Bohannon and H. W. Richardson, of Louisville, and A. L. Rich, of Cincinnati, are large holders, will be rebuilt and extended. The work is in the hands of the Tennis Construction Company. It is contemplated by the owners of the property to extend the road to Evansville.

BOSTON, MASS.—The National Exchange Bank, of Providence, has filed two bills in the United States Circuit Court against the Lowell & Boston Street Railway Company and the Concord & Boston Street Railway Company, seeking appointment of receivers for each company. The bank alleged that the Lowell & Boston Company is indebted to it for $9,000, and the Concord & Boston Company for $10,000.

ST. LOUIS, MO.—On April 30, the first day of the World's Fair, the St. Louis Transit Company carried 927,000 passengers. Average daily volume of traffic since then has been from 350,000 to 400,000.

KANSAS CITY, MO.—The Metropolitan Street Railway Company has secured a permit to erect a power house sub-station at the southwest corner of Twelfth Street and Cleveland Avenue. It will be completed in about sixty days. The cost is estimated at $20,000.

KANSAS CITY, MO.—A charter has been granted for another electric railway between Kansas City and Topeka by way of Lawrence, Olathe and Rosedale. It is known as the Kansas City, Lawrence & Topeka Railway, and its capital stock is $1,000,000. The following-named officers have been elected: Henry G. Pert, president; George Leis, of Lawrence, vice-president; W. A. Bunker, Kansas City, Mo., treasurer, and J. G. Hughes, of Kansas City, Kan., secretary.

KANSAS CITY, MO.—The Kansas City, Burlingame & Western Electric Railway has filed articles of incorporation in Topeka. The capital stock is given as $2,000,000. The officers are: President, Hugh A. Holmes; vice-president, J. T. Pringle, Burlingame, Kan.; second vice-president, E. J. Hilky, Overbrook, Kan.; third vice-president, J. O. Southard, Allen, Kan.; treasurer, J. P. Slaughter, Burlingame, Kan.; secretary, Charles G. Taylor, Burlingame, Kan. The road incorporated will connect with the Kansas City & Olathe line at Olathe. It will run through Baldwin, Overbrook and Burlingame to Council Grove, a distance of 100 miles. Much of the right of way of the Burlingame line has already been secured. The road is to be in operation in eight or nine months. Cars may be running to Baldwin in five months. The line chartered is part of the system which includes the Kansas City & Olathe line, and the Kansas City, Lawrence & Topeka road. The Olathe line is to be in operation this summer. Electric cars may be running into Topeka by next spring.

RENO, NEV.—Money has been provided for the commencement at once of work on the proposed railway between this city and Sparks. California capitalists are the promotors, who are represented here by S. N. Griffith.

NEWARK, N. J.—The Public Service Corporation has announced the schedule of the passenger service between Jersey City and Philadelphia, which went into effect Friday, May 13. The first car leaves Jersey City at 8.35 A. M., and will leave Broad and Market Streets, this city, at 9.28 A. M., arriving at Trenton at 1.50 P. M. At Trenton close connections will be made with a boat of the Delaware Navigation Company for Philadelphia. The sail down the river will take about four hours. Three other cars will leave New York at 11.20 A. M., 2.20 P. M., and 5.20 P. M., and returning cars will leave Trenton at 8 and 11 A. M., and 2 and 5 P. M., arriving at Newark at 12.30, 3.32, 6.32 and 9.32 P. M. The cars will pass through Elizabeth, Westfield, Plainfield, Bound Brook and New Bruswick.

MIDDLETOWN, N. Y.—The sale of the Middletown-Goshen Electric Railway will be held May 26. The date of the sale was originally set for April 28.

ROCHESTER, N. Y.—The highway commissioners of the town of Wheatland have granted permission to the promoters of the Rochester, Scottsville & Caledonia Electric Railway Company to pass through that town. The road will be capitalized at $250,000. Articles of incorporation have been forwarded to Albany.

HUNTINGTON, N. Y.—The Huntington Railroad Company, owned and operated by the Long Island Railroad Company, has signed a contract with the Huntington Light & Power Company, whereby the last named is to furnish power to operate the road. The plant of the Light & Power Company will be about doubled in size. New engines will be installed at once. The power used at present is furnished by gas engines.

ELIZABETH CITY, N. C.—David E. Evans, president of the Elizabeth City Electric Light Company, is planning to organize a company to build an electric railway here.

COLUMBUS, OHIO.—The bill passed by the Legislature giving electric railways practical power of eminent domain in municipalities is now the law in Ohio, as the Governor has allowed ten days to elapse without either signing or vetoing it.

NORWALK, OHIO.—Citizens of Norwalk have subscribed nearly all the $100,000 in bonds to secure the building of the Sandusky, Norwalk & Mansfield Railway between Norwalk and Plymouth. Construction work on the road will probably start in the near future.

CLEVELAND, OHIO.—The Cleveland Electric Railway Company is closing a contract with the Electric Storage Battery Company, of Philadelphia, for a storage battery outfit to have a capacity of 1600 amperes for one hour. The battery will operate in connection with a booster set, and will be located on Detroit Street to assist with the loads on the west side lines of the company.

CLEVELAND, OHIO.—The Mansfield & Eastern Traction Company has placed a contract with the Reisinger-Proctor Company, of Pittsburg, for the construction of 17½ miles of road from Mansfield to Ashland by way of Mifflin, with a spur to Petersburg Lake. Plans for the road have been prepared by the General Engineering Company, of Cleveland, and it is stated that construction work will start before June 1. The bonded indebtedness of the company will be $450,000, and one-third of the amount has been underwritten. David Morrison, of Cleveland, is at the head of the company.

INDIANA, PA.—The Town Council has granted the necessary franchises to the Indiana Street Railway Company to enable it to construct its proposed lines.

WASHINGTON, PA.—The Wheeling & Elm Grove Railway Company, which operates from Wheeling to West Alexander, will extend its lines to Washington and form a link in the line from Pittsburg to Wheeling.

HARRISBURG, PA.—The Valley Traction Company has bought the Baltimore, Westminster & Gettysburg Electric Railway Company. The Valley Traction Company has also acquired the Hampden Street Railway and the South Middletown Electric Railway, their respective rights and franchises.

STROUDSBURG, PA.—The Northampton & Monroe Electric Railway Company, shortly to commence operations between Stroudsburg and Bangor, is to be extended to Mount Pocono, Tobyhanna and thence to Scranton. It is believed that the line will be constructed and in operation within two years.

UNION, S. C.—T. C. Duncan has organized a company to build an electric railway between Roebuck and a point on the Georgia Central & Northern Railroad, via Neal Shoals.

CHATTANOOGA, TENN.—At a meeting of the Rapid Transit Company stockholders it was decided to issue bonds to the extent of $1,000,000, of which $250,000 will be spent in improvements. The present officers of the company were re-elected.

SEATTLE, WASH.—The Seattle, Renton & Tolt Electric Railway Company has been incorporated with a capital stock of $750,000. The trustees are W. H. Goldson, P. J. Farley and Edwin S. Gill.

SEATTLE, WASH.—Articles of incorporation of the Snohomish & Cherry Valley Electric Railway are ready for filing. The capital stock of the company is to be $1,250,000. The road will connect Snohomish and Tolt by way of Monroe and Cherry Valley.

HALIFAX, N. S.—G. Martin Brill, of the J. G. Brill Company, of Philadelphia, Pa., is president of a company organized to construct an electric railway in Nova Scotia. The corporation will take over 50 miles of roadway that has already been surveyed.

TORONTO, ONT.—The Toronto Street Railway Company is increasing its power capacity by installing a plant which will bring the total output up to 10,000-hp, with a reserve storage battery capacity of 3000-hp in addition. The company has also secured an additional 200-hp from the old Metropolitan power house at Eglington, a suburban line recently secured by the company.

NEW INDUSTRIAL COMPANIES.

THE TURBINE ELECTRIC TRUCK COMPANY, of New York, has filed a certificate of increase of capital stock from $100,000 to $300,000.

THE INTERNATIONAL RAILWAY SIGNAL COMPANY, of Winston, N. C., has been chartered with a capital stock of $250,000. A. H. Eller and others are the stockholders. The purpose of the company is to equip railways with a new signal system and sell rights to use the same.

THE CLINTON STAMPING & ELECTRIC COMPANY will establish a plant at Clinton, Ia., for the manufacture of a combined lightning arrester, ground switch, fuse and lever cut-off for telephones. The company will also manufacture knife switches and engage in electroplating.

THE BLACK HAWK ELECTRIC COMPANY has been incorporated at Davenport, Ia., for the purpose of dealing, besides its present business, in electrical appliances, repairing automobiles, etc. The capital stock is $10,000. The officers of the company are W. A. Fuller, president; James E. Bayles, vice-president; John H. Eagel, secretary and treasurer.

THE MARTIN-REYNOLDS ELECTRIC COMPANY, of Little Rock, Ark., has been incorporated with a capital stock of $15,000, of which $4000 has been subscribed. The incorporators are Ed. Cornish, Robert E. Wait, M. B. Sanders, T. B. Martin, Jr., E. T. Reynolds, C. E. Robinson, Ed. M. Pennington, A. D. Reynolds, E. T. McConnell, R. D. Dunlap and D. T. Reynolds.

THE AKRON INSULATOR & MARBLE COMPANY and the Colonial Sign Company, both of Akron, Ohio, have consolidated under the title Colonial Sign Company. The plant of the Insulator Company will be removed to that of the Colonial Sign Company in South Akron and the new concern will continue to manufacture the same line of articles produced heretofore by the separate companies. The capital stock has been increased to $50,000. Mr. H. B. Camp is president of the new company; G. D. Chapman, vice-president; C. R. Quine, secretary; W. H. Motz, treasurer, and J. R. Hemphill, general manager.

OBITUARY.

MR. NELSON PERIN.—Mr. Nelson Perin, one of the leading financiers of Baltimore, Md., after a long illness, aged fifty-one years, died on May 12. He was one of the pioneers of rapid transit in Baltimore, and was the first president of the United Railways and Electric Company, which combined all the street railways of the city. He retired from the presidency of the company three years ago. Mr. Perin also was a promoter of the present system of electric lighting.

GEN. A. HICKENLOOPER.—The death is announced at Cincinnati, Ohio, of Gen. Andrew Hickenlooper. He rose from captain to brigadier in the Civil War, and was a famous commander of artillery in the Union Army. After the war he was civil engineer of Cincinnati, and for the past thirty years president of the Cincinnati Gas & Electric Company. He was Lieutenant-Governor of Ohio from 1880 to 1882. Gen. Hickenlooper was sixty-seven years old. He was long noted for his prominent connection with gas interests in Cincinnati and for the virulence of his opposition to electric lighting.

PERSONAL.

MANAGER SCOTT, of the Cutter Company of Philadelphia, has returned from a short trip to Europe.

MR. H. A. RHODES, chief engineer of the Colorado Telephone Company, has gone from Denver to St. Louis on a combined business and pleasure trip.

DR. S. S. WHEELER, president of the Crocker-Wheeler Company, of Ampere, N. J., has just returned to New York from a brief trip to Europe.

MR. ERNEST F. LARNED, of Boston, formerly with Stone & Webster, has arrived in Tacoma, Wash., on a tour of inspection of engineering propositions in the Far West.

MR. JOSEPH H. THOMPSON, JR., has opened an office at 11 Broadway, New York City, for the purchase, sale or exchange of new and second-hand electrical and steam machinery.

MR. D. MAZENET, managing director of the Mexican General Electric Company, which represents the interests of the General Electric Company, will pay a visit to the United States headquarters early next week.

MR. AUGUSTA WITZIG, of the Societe l'Eclairage Electrique de Paris is now on this side. The French concern is represented in the United States by the Goudey-McLean Company, 120 Liberty Street, New York.

MR. J. H. HALLBERG has opened an office at 45 Broadway, New York City, as consulting expert in electrical distribution and illumination, a branch of work for which his training and experience qualify him admirably.

MR. JAMES H. McGRAW, president of the McGraw Publishing Company, has been elected a delegate for New Jersey to the Republican National Convention which will meet in Chicago in June to choose a presidential candidate.

MR. J. C. McQUISTON, formerly secretary of the Publishing Department of the Westinghouse companies, has been made its superintendent and responsible head. He will be charged with matters of advertising, preparation of technical articles, etc.

MR. J. C. BOYNTON, toll traffic manager of the Colorado Telephone Company at Denver, has resigned his position with that company and gone to Newcastle, Pa., where he will probably continue his work in connection with telephone traffic problems.

MR. LOUIS F. PHILO, who for the past six years has been connected with the Wesco Supply Company, in the capacity of manager of the supply department, has become assistant manager of sales with the Ewing-Merkle Electric Company of St. Louis.

MR. J. G. WHITE, president of the electrical engineering and contracting firm of J. G. White & Company, Inc., New York, will sail for Europe May 24 on the North German Lloyd liner *Kaiser Wilhelm der Grosse*. He expects to be absent about three months.

MR. FRED A. GEIER, secretary and treasurer of the Cincinnati Milling Machine Company, who has been abroad some time, has just returned home from Europe, having greatly enjoyed the change and seen a good deal of industrial conditions on the other side.

MR. W. OWEN THOMAS, electrical engineer of the Michigan Lake Superior Power Company at Sault Ste Marie, Mich., has severed his connection with that large undertaking to become assistant to the mechanical engineer of the Chicago & Northwestern Railway Company, at Chicago.

MR. CHARLES H. HASWELL, known to all engineers the world over, celebrates his ninety-fifth birthday Sunday, May 22, and his friends in this city where he was born in 1809 are giving him a dinner at the Engineers' Club on Monday next. The veteran will enjoy a story and a cigar with the liveliest of them.

MR. JAS. R. CRAVATH recently addressed the Armour Institute of Technology branch of the A. I. E. E. on the subject of "Illumination," taking up first the general subject of how to secure the best results for a given expenditure of money for electric light, and following with some specific examples and practical suggestions.

ARTHUR FRANTZEN & COMPANY.—The electrical engineering and contracting firm of Arthur Frantzen & Company, Chicago and Baltimore, has entered the Mexican field. Branch offices have been opened in the Mexican capital under the management of Mr. A. B. Boynton. Mr. A. W. Maulsly will be assistant manager.

MR. H. M. DIEFFENBACH, who recently resigned as general manager of the Mexican end of the American Smelting & Refining Company, has beeen appointed general manager of the Compania de Minelales y Metales of Mexico City. This concern controls the Penobles Mining Company, which will be in the market for a big lot of electrical equipment very shortly.

MESSRS. J. CICERON CASTILLO and F. Mendoza Alvirez have recently established themselves in Morelia, State of Michoacan, Mexico, under the firm name of Castillo y Compania. They will inaugurate a department to be devoted to the installation of hydro-electric machinery, etc., for operating mines, etc., and have already obtained some fair-sized contracts.

MR. HERMANN RUETE, until recently associated with the export commission house of G. Amsinck & Company, Hanover Square, New York, is about to leave for Germany, where he will enter his father's firm, Ruete & Schutte, of Hamburg, which is one of the largest commission houses in that part of the world. A new department is to be created for the purpose of handling American electrical equipment, supplies, etc. Mr. Ruete's address is 128 Water Street, New York.

MR. CHARLES J. GLIDDEN, the chairman of the Boston touring committee of the American Automobile Association, who at present is abroad, will return in June and take up the active work of organizing the New England Division. Mr. Glidden will start his grand tour of the world by going from New York to St. Louis with the run from there to San Francisco. Before leaving New York, Mr. Glidden stated that he expected to bring Mr. Edge of Gordon-Bennett fame back with him to drive a Napier in the tour.

MR. H. WARD LEONARD, president of the company bearing his name, has resumed work, and we are very glad to state that he is entirely restored to health. He had to go into hospital on account of his eyes. He had considerable trouble with an attack of iritis, due to the results caused by arcing, and consequent upon tests he made in connection with making and breaking the circuit of several large motor starters built under his supervision at the Bronxville works. He is quite cured of this trouble and his eyes are in good condition.

MR. HERBERT LAWS WEBB has an interesting article in the London *Daily Mail* on the manner in which the telephone as a necessity in New York becomes a luxury in London. "British bankers will not use the telephone service. In America bankers are wholesale users of the telephone. In London there is not a hotel having telephone service in all the rooms. In New York the hotel which does not have the city telephone service in every room is the exception. The Metropolitan police refuse to use the telephone. The New York police have an elaborate system of their own and connection with the general system at every station. In New York for years past the police have managed all large processions by telephone. In London the police and the military manage processions by flag signalling! The broad difference between the American and the British public, and their respective authorities, is that the former welcome all devices aiming at saving time and increasing efficiency, while the latter resist them to the last ditch."

EDUCATIONAL.

HARVARD AND "TECH."—Advices from Boston of May 14 say: "Negotiations between the Institute of Technology and Harvard University looking toward their union have been formally opened by the Institute. It was announced to-day at the office of President Pritchett that a resolution of the corporation of the Institute had been formally transmitted to the corporation of Harvard. This resolution is as follows: "Voted, that the executive committee be required to ascertain whether any arrangement can be made with Harvard University for a combination of effort in technical education such as will substantially preserve the organization control, traditions and name of the Massachusetts Institute of Technology."

Trade Notes.

THE HAZARD MFG. COMPANY, of Wilkes Barre, Pa., has opened its own office and warehouse at 71 and 73 West Adams Street, Chicago, Ill.

MR. W. S. BROWN, New York representative of the Chase-Shawmut Company, Boston, has moved his offices to the Bancroft Building, 3 West Twenty-ninth street.

THE PERKINS MACHINE COMPANY, maker of power presses, has removed its main office from South Boston to its Warren plant at Warren, Mass. The company is receiving large orders for its machine from its German agents, Messrs. Schuchardt & Schutte, of Berlin.

THE F. BISSELL COMPANY, of Toledo, Ohio, has issued Bulletin No. 31 devoted to tape, solder, screws, insulating materials and carbon brushes. This bulletin becomes part of its new illustrated catalogue, and will be sent on request to any user of electrical goods.

GARTON-DANIELS COMPANY, Keokuk, Ia., has issued No. 40 catalogue, which embraces all details as to its full line of lightning arresters. This catalogue has already run in to more than one edition. It deserves the general circulation and demand it is enjoying. Businesss in these arresters for the first three months of 1904 shows a large increase over any previous period and the demand continues progressively.

H. T. PAISTE COMPANY, Philadelphia, Pa., is pushing its new P. K. "Pushin" attachment plug, and calls attention to its new principle of inserting without any backward or forward twisting of the cord. The inquiries and orders for it have already been most gratifying, beyond anything that was expected. This device is described and illustrated on page 1004 of this issue.

SELF-SOLDERING HEAT COILS.—Mr. Frank B. Cook, 240 W. Lake Street, Chicago, has an exclusive license to manufacture and sell all self-soldering heat-coils and other circuit protecting devices and apparatus covered by patents and applications for patents, as well as any devices of that kind, which may hereafter be invented by Charles A. Rolfe, or owned and controlled by the Rolfe Electric Company. All other licenses have been withdrawn.

HOLTZER-CABOT ELECTRIC COMPANY, Brookline, Mass., has just issued a new bulletin on motor generators, No. 302. It is somewhat larger and more comprehensive than the old bulletin, and covers its subject and its field most completely. An appendix of several pages has been added, which treats of the various forms of the telephone machinery of this class, showing the latest apparatus in this line. In fact, it is a most interesting catalogue and should be in great demand.

JAMES LEFFEL & COMPANY, Springfield, Ohio, have just issued a catalogue of 40 pages devoted to their steam engines, boilers and turbine water wheels. The engines and boilers are illustrated in full detail and descriptions are given of both classes of apparatus. Dimensions, sizes, etc., are also furnished, and from this catalogue the intending purchaser can obtain an excellent idea as to the best manner of satisfying his wants. The catalogue also illustrates the well known turbines made by this firm and the Leffel portable vertical engines, as well as Leffel upright engines and submerged tube boilers..

SIDE CUTTING PLIERS.—Mathias Klein & Sons, 87 and 89 West Van Buren Street, Chicago, are now making side cutting pliers in 6, 7 and 8 inch sizes, the 6-inch being a recent addition made to the line by general request. They make also a full line of climbers, splicing clamps, pliers, wire grips, pulley blocks, etc., and carry a general assortment of linemen's and construction men's requisites in such particulars. They also distribute "a good rule" which they will be pleased to send gratis to interested people.

ADAMS-BAGNALL ELECTRIC COMPANY, of Cleveland, Ohio, in its recent bulletins gives a number of illustrations and a variety of details as to its well-known arc lamps, for all classes of service. These lamps have been on the market for a number of years, and are standard features of the art. The company has paid special attention lately to the alternating current series type of lamp, with all the necessary parts and accessories, and its literature on the subject shows both the apparatus and the manner of connecting up the circuits, with particular attention to the regulator for the alternating constant current.

POP CONCERT AT THE ELECTRIC LIGHT CONVENTION.—A pop concert will be held at Symphony Hall, Boston, on the evening of May 25, during the convention of the National Electric Light Association. Mr. Geo. C. Ewing, Nernst Lamp Company, 501 Atlantic Ave., Boston, informs us that delegates may obtain free tickets by addressing him by mail or applying to him personally on their arrival at Boston. There will be approximately 600 seats at tables of 4 or 5 each, and it is proposed to make the evening a very enjoyable one for the delegates.

NEW BOILER FEED SYSTEM.—Frank E. Keyes, manager of the Refined Wood Company, of 20 Broad St., New York, has devised and patented an improved and very effective boiler feed system by which the water is purified, then put into the boiler under any pressure at a boiling point, without the use of pumps, injectors or inspirators, namely by gravity. It is claimed that the simplicity and the low cost of installation will appeal to all steam users. As the water is purified before going into the boiler, it is possible to run the boiler much longer without cleaning. A steady supply of clean hot water is insured, giving the greatest efficiency with the least amount of fuel.

KEYSTONE ELECTRIC COMPANY, Erie, Pa., has issued a handsome quarto catalogue devoted to its generators, motors, switchboards, panel boards, etc. It is a pamphlet of 40 pages, and is profusely illustrated, showing complete and in detail a large variety of excellent apparatus in these lines of production. A valuable part of the catalogue is that which gives detailed diagrams and dimensions of the machinery. We note a new type of brush holder, and the switchboards are also admirable types of that class of work. A section is devoted to the application of Keystone motors to machine tools, ventilating fans, etc., exemplifying a wide range of use for their power apparatus.

SLOTTING MACHINES.—The Newton Machine Tool Works, Philadelphia, Pa., in a recent catalogue, illustrate and describe a very complete line of slotting machines particularly adapted for use on electrical machinery and large engine work. These machines are made to be belt driven or motor driven, and range from 6 in. to 18 in. stroke. Each illustration is accompanied by dimension tables. Other machines illustrated are a 40-in. gear cutting machine; an armor plate slotting machine; milling machine; cold saw cutting-off machines, etc. The illustrations are very clear and the machines have a very massive and substantial appearance.

THE STUART-HOWLAND COMPANY, Boston, Mass., reports a decided improvement in business with the opening of spring. It has recently secured several large orders, three of which are for shipment abroad. These, in addition to the ordinary business will keep its force very busy for some time to come. This company is located in the very heart of Boston, within one hundred feet of Summer Street and within four minutes' walk of the new terminal station. Its offices and warerooms are large, light, airy and especially convenient for handling goods at a minimum cost. It carries one of the largest and most complete lines of electrical goods to be found in the United States. The push, energy and up-to-date methods of this concern are too well known to the trade to require further comment.

CARBORUNDUM IN BUTTON MAKING.—Hitherto pearl buttons have been cut and drilled with steeled tools. An inventor named Louis W. Holub has devised a means of grinding them out of the raw mother-of-pearl by means of carborundum. The firm of Holub-Dusha Co., 1801-3 First Ave., New York, is now doing this. A little girl sits in front of the machine, feeding it, and just as fast as her little fingers can go the machine finishes the work, whether the button is ¼ inch or three inches in diameter, whether the surface is to be straight, concave, convex, or the form of the button be that of round, oval, square, hexagon, triangular, or of any other form. The machine consists of a flat, slowly revolving, round, horizontal turn-table of about two feet in diameter. Near to its outer periphery is mounted a plurality of vertical button chucks, revolving rapidly around their own axes while slowly moving the turn-table. These chucks describe a circle of about 22 inches in diameter. Into this circle is mounted, eccentrically in relation to the chucks, a horizontally revolving carborundum wheel mounted on a vertical shaft. The diameter of the wheel is about 20 inches. As the carborundum wheel is 2 inches smaller in diameter than the circle described by the chucks, it comes in contact with but few of the buttons at a time, and thus leaves the rest of the chucks free for manipulation, such as placing the button therein, gripping it, taking out the finished product, and freeing it of dust, etc. When this so-called "merry-go-round" is in motion the carborundum wheel makes 5000 revolutions per minute, the chucks about 600, and the turn-table about 15 revolutions. When the chucks arrive before the little girl they are open and do not revolve around their own axes, but move with the turn-table. A button blank is placed therein. The chuck automatically grips it, begins to revolve with it, and brings it in contact with the lower side of the carborundum wheel. Terrific grinding takes place and in less than a second the top of the button is ground. When it has passed the grinding wheel the chuck ceases to revolve, it opens automatically, and the button is now under a suction tube that lifts it out of the chuck, taking with it every particle of dust, and the now clean and open chuck is once more before the little girl to receive a new blank to be ground. If the button should be convex or half round, then the lower or outer end of the carborundum wheel is dressed concave with a diamond. The wheel being intensely hard, it holds its shape for days, and it is re-dressed at a trifling cost.

ZINC.—In a very neat and illustrated pamphlet, recently issued by the Lanyon Zinc Company, "Two Stories of Zinc" are told, the first being the story of spelter. The various steps in the reduction of zinc from the ores are clearly described and a sketch is given of a day's work in a zinc smelter plant. The ore is first crushed and then treated in the calcining kilns where it is desulphurized, the zinc sulphide being changed into oxide and the sulphur passing off as sulphur dioxide. The temperature in these kilns is in the average 1700 degrees F., but is gradually increased as the period of calcination progresses. The zinc oxide is then mixed with finely ground coal and fairly coarse coke or coal in order to be reduced in the distillation furnace. In this step of the process zinc is treated in quite a different way from other metals. Zinc ore cannot be melted nor can any zinc be extracted by the usual methods of treating ores. Gold, for example, is placed in the furnace in company with the metals known as fluxes, which collect in the bottom of the furnace and late in the process are drawn off in the form of bullion containing the gold which is afterward refined and the metals separated. Zinc, when placed in contact with intense heat, is transformed into a vapor, and then recovered in condensers. This is done in the distillation furnace. The presence of any fluxing material in the smelting of zinc would be a positive detriment. On account of this method of distillation the losses of zinc during the treatment are high compared with other metals and average from 10 to 30 per cent. of the metallic contents of the ore. The Story of Sheet Zinc is next told in the pamphlet. The operation is one requiring skilled help and constant watching. The choicest of spelter is used. It is first melted in a huge pot and then poured into moulds and billets are cast. The billets are annealed and treated in the first or "roughing" rolls. They are then again annealed and treated in the finishing rolls. The last operation is the most delicate one of the process. The applications of sheet zinc have rapidly increased during the last 30 years. Among the more common uses of sheet zinc are the manufacture of metallic ceilings, stove boards, linings of refrigerators, and it is largely used in the zinc process for the extracting of gold from its ores. The use of small galvanic cells takes quite a large tonnage of this metal in the course of a year, since it has been demonstrated that batteries and rods made from sheet zinc are of a more satisfactory character than those which are cast. In recent years, the manufacture of nickel, copper and brass plated sheet zincs has grown rapidly, and they have entered into formidable competition with sheet brass and sheet copper.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MAY 10, 1904.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

759,237. CIRCUIT CHANGER; Charles C. Cadded, Cleveland, Ohio. App. filed June 15, 1903. Strip metal, spring contacts are actuated by a spreader carried by a lever and which moves in the space between the contacts.

759,276. INSULATOR FOR TELEGRAPH WIRES; Clayton Hobert, Philadelphia, Pa. App. filed April 10, 1903. A knob having grooves in the top arranged at various angles and a second knob or cover screwing down upon the first to hold a wire in one of the grooves.

759,280. TELEPHONE ATTACHMENT; Stephen C. Houghton, San Fancisco, Cal., and Frank M. Potter, Jr., Syracuse, N. Y. App. filed Dec. 30, 1903. (See page 987.)

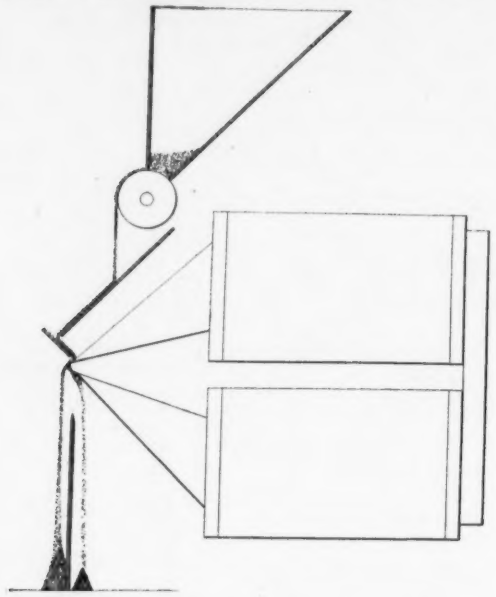
759,281. SIGNALING; Gustav A. Huber, Mounthope, N. Y. App. filed Jan. 9, 1904. General improvements in a magneto generator and selector.

759,286. ELECTRICITY METER; Martin Kallman, Berlin, Germany. App. filed Sept. 28, 1901. An armature deflected by the current has a to-and-fro motion which rotates a wheel in one direction giving it sufficient momentum at each impulse to keep the motion continuous between impulses.

759,316. TELEPHONE-RECEIVER; Walter C. Runge, London, Eng. App. filed Dec. 6, 1902. (See page 987.)

759,327. RAILWAY SWITCHING AND SIGNALING APPARATUS; John D. Taylor, Buffalo, N. Y. App. filed Oct. 25, 1901. Devices for preventing crosses on the wires of the system.

759,346. RAILWAY BLOCK SIGNAL SYSTEM; Winthrop M. Chapman, Newton, Mass. App. filed May 12, 1902. Various details of construction.



759,358.—Magnetic Separating Apparatus.

759,352. METER FOR MEASURING ELECTRICAL ENERGY; Louis P. Decombe, Paris, France. App. filed Nov. 26, 1901. The fine wire spool forms part of a system arranged in such a manner that the number of ascillations of a spool on a suitable axis is proportional to the energy consumed in the distribution.

759,358. MAGNETIC SEPARATING APPARATUS; Thomas A. Edison, Llewellyn Park, N. J. App. filed June 21, 1900. The separator consists essentially of an electro-magnet having extended tapering poles, one of which slightly overlaps the other to form a narrow gap between them whereby the magnetic particles will be attracted by the lines of force towards one of the poles and caused to fall into a compartment separate from that which receives the non-magnetic particles.

759,383. COMBINED SWITCH-SOCKET AND RESTORING-ANNUNCIATOR; Anton M. Knudson, Chicago, Ill. App. filed Oct. 13, 1900. (See page 987.)

759,385. RAILWAY SWITCH AND OPERATING MEANS THEREFOR; Lucius A. Lindsay, Strubbe McConnell and Clifford C. Hudson, Atlanta, Ga. App. filed Nov. 23, 1903. A circuit closing device actuated from the platform to energize magnets in the road bed for moving the switch tongue.

759,414. GROUND WIRE ATTACHMENT; Wilbert J. Bishop, Buffalo, N. Y. App. filed Sept. 4, 1902. A strap to embrace a pipe and carrying a roughened plate which bites into the pipe to make good contact.

759,426. ELECTRIC SOLDERING IRON; Sydney Evershed, London, Eng. App. filed Dec. 8, 1903. Details.

759,428. TELEPHONE-TRANSMITTER HOOD; Robert D. Fannon, Chicago, Ill. App. filed Oct. 29, 1901. (See page 987.)

759,431. ELECTRIC ACCUMULATOR; Ricardo Fortun and Eduardo Semprun, Madrid, Spain. App. filed Sept. 30, 1901. (See page 986.)

759,433. TROLLEY; Elmer E. Gillingham and Delancy E. Huntley, Wellston, Ohio. App. filed April 27, 1903. Two wheels mounted on a two-part frame, the members of which are hinged together, permitting the wheels to assume different vertical planes.

759,441. TELEPHONE TRANSMITTER; Alfred W. Hill, West Hoboken, N. J. App. filed Oct. 9, 1902. (See page 987.)

759,453. ELECTRIC RAILWAY; Timothy Mahoney, San Francisco, Cal. App. filed July 1, 1903. The two ends of the third rail are directly connected to the dynamo and means are provided for shunting the current from the rail through the car and back to the rail again.

759,464. ALARM SYSTEM; Felix McGloin, New York, N. Y. App. filed Dec 31, 1902. Improvements in non-interfering mechanism for alarm circuits.

759,492. TELEPHONE EXCHANGE; Clarence A. Anderson, Salina, Kan. App. filed Dec. 5, 1901. (See page 987.)

759,506. MEANS FOR AND METHOD OF SECURING LEAD-IN WIRES IN ELECTRIC LAMPS; John C. Entriken and Wm. S. Everett, Malvern, Pa. App. filed Jan. 21, 1904. That portion of the leading-in wires embedded in the glass is of platinum, as usual, but the remainder of the leading-in wire is of another and cheaper metal.

759,511. LIGHTING SYSTEM FOR LOCOMOTIVES; Ethelbert T. Ford, St. Louis, Mo. App. filed Dec. 21, 1903. A system of circuits and apparatus for operating the headlight and incandescent lights in the cab from the same dynamo and means whereby either circuit can be used alone.

759,543. ELECTRIC RAILWAY SIGNAL; Elwood W. McGuire, Richmond, Ind. App. filed Aug. 15, 1902. Details.

759,550. SECONDARY-BATTERY ELECTRODE; Charles J. Reed, Philadelphia, Pa. App. filed Jan. 16, 1901. (See page 986.)

759,586. ELECTRIC SWITCH; Henry C. Baer, New York, N. Y. App. filed Nov. 9, 1903. Details of a fixture switch.

759,600. ELECTRICAL SWITCH; Fay L. Faurote, Ann Arbor, Mich. App. filed March 14, 1903. A switch having a "combination" attachment which must first be properly set before the circuits can be closed.

759,615. BURGLAR ALARM; Arthur J. Kercher, Minneapolis, Minn. App. filed Oct. 9, 1903. An electro-static circuit closer which normally holds the circuit in an open condition by the attraction between two sets of electrically opposite plates.

759,632. SWITCH FOR INCANDESCENT LAMP SOCKETS; John D. Raymond, Chicago, Ill. App. filed Feb. 1, 1904. Details.

759,641. SIGNALING APPARATUS FOR TELEPHONE-SWITCHBOARDS; Edwin H. Smythe, Freeport, Ill. App. filed Jan. 26, 1903. (See page 987.)

759,650. MANUFACTURE OF SMALL INCANDESCENT LAMPS; Allen D. Whipple, Chicago, Ill. App. filed Dec. 5, 1903. (See page 988.)

759,652. RAILWAY SIGNAL; John W. Anderson, Jr., Woodland, Ill. App. filed Feb. 20, 1903. Details.

759,697. TELEPHONIC APPARATUS; Alfred Graham, London, Eng. App. filed Feb. 4, 1903. (See page 987.)

759,701. FACSIMILE TELEGRAPH APPARATUS; Ernst Karl Gruhn, Dresden, Germany. App. filed Nov. 21, 1902. An arrangement for preventing erroneous variations of the resistance, comprising a peculiar arrangement of a curved contact piece, bearing upon the resistance and having a certain relation to the motion of the controlling fulcrumed lever.

759,722. ELECTRIC HEATER OR RHEOSTAT; Max C. Krusger, Chicago, Ill. App. filed Oct. 6, 1902. A series of resistance plates superposed upon each other and with insulating material between them, all being clamped together.

759,740. BATTERY; Jay Noble and Edward L. Anderson, St. Louis, Mo. App. filed June 1, 1903. (See page 986.)

759,741. ELECTRIC BLOCK-SIGNALING AND TELEPHONING SYSTEM FOR RAILWAYS; Charles Goodman Otwell, and Ira Howard Melvin, Laurel, Del. App. filed Feb. 11, 1904. (See page 987.)

759,762. SIGNALING APPARATUS FOR TELEPHONE-SWITCHBOARDS; Edwin H. Smythe, Freeport, Ill. App. filed Sept. 14, 1903. (See page 987.)

759,767. RAIL SUPPORT; Louis Steinberger, New York, N. Y. App. filed Jan. 7, 1904. The rail chair is constructed to rock on its support to permit the rail to conform to pressures applied to it.

759,771. SIGNAL APPARATUS FOR TELEPHONE-SWITCHBOARDS; DeWitt C. Tanner, Chicago, Ill. App. filed March 27, 1902. (See page 987.)

759,787. CABLE HANGER; Frank E. Wey, Wheeling, W. Va. App. filed May 16, 1903. A special kind of strap.

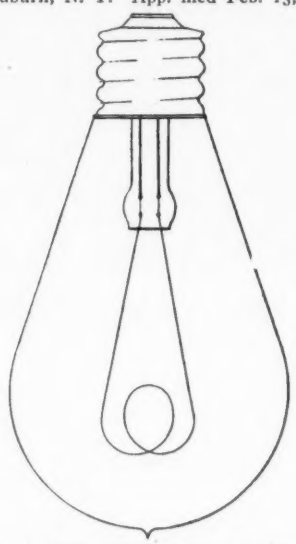
759,796. LIGHTNING ARRESTER; John C. Barclay, New York, N. Y. App. filed Sept. 9, 1903. A lightning arrester of special construction is combined with an inclosed fuse.

759,797. RHEOSTAT; John C. Barclay, New York, N. Y. App. filed Nov. 18, 1903. A telegraph rheostat comprising a variable resistance for insertion in an artificial line and a separate terminal connected to an intermediate point in such resistance and adapted for connection to a main line to compensate for battery resistance.

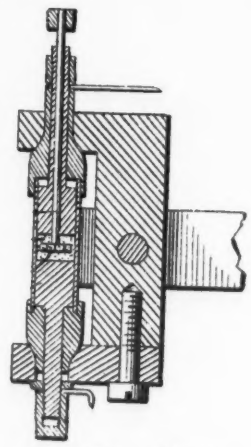
759,798. ELECTROLYTIC APPARATUS; Henry Spencer Blackmore, Mount Vernon, N. Y. App. filed July 22, 1903. (See page 986.)

759,799. ELECTROLYTIC APPARATUS; Henry Spencer Blackmore, Mount Vernon, N. Y. App. filed July 22, 1903. (See page 986.)

759,814. DOOR-LOCK-ACTUATED CIRCUIT BREAKER; Grayson G. Knapp, Auburn, N. Y. App. filed Feb. 13, 1903. Details.



759,506.—Means for and Method of Securing Lead-in Wires in Electric Lamps.



759,835.—Coherer.

759,825. WIRELESS TELEGRAPH APPARATUS; Joseph Murgas, Wilkesbarre, Pa. App. filed Oct. 2, 1903. In this system the message depends upon the character of the impulses, as the frequency, intensity, etc., rather than their time relation.

759,826. METHOD OF COMMUNICATING INTELLIGENCE BY WIRELESS TELEGRAPHY; Joseph Murgas, Wilkesbarre, Pa. App. filed Feb. 24, 1904. A modification of the preceding invention.

759,835. COHERER; Austin H. Stewart, Nashville, Tenn. App. filed Oct. 20, 1903. The agitator is within the tube and is actuated by a rod passing to the outside.

759,836. GENERATOR FOR TELEPHONE-CALLS; Ernest Hugo Strauss, Chicago, Ill. App. filed Nov. 17, 1902. (See page 987.)

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(*Continued on page* 111.)

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1	50	C. & C.
1	50	Commercial, Multipolar.
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1	55	Eddy, Multipolar.
1	60	Northern, Multipolar.
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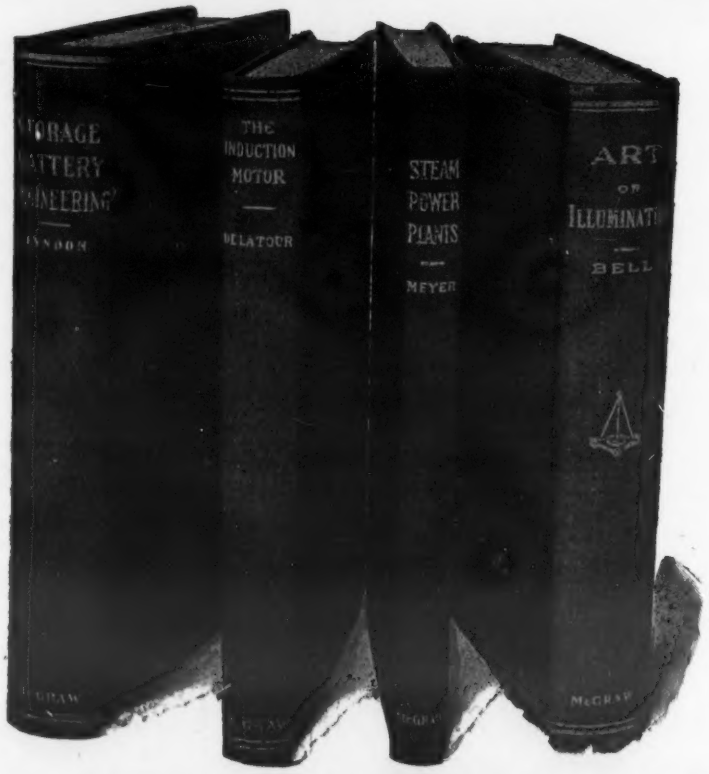

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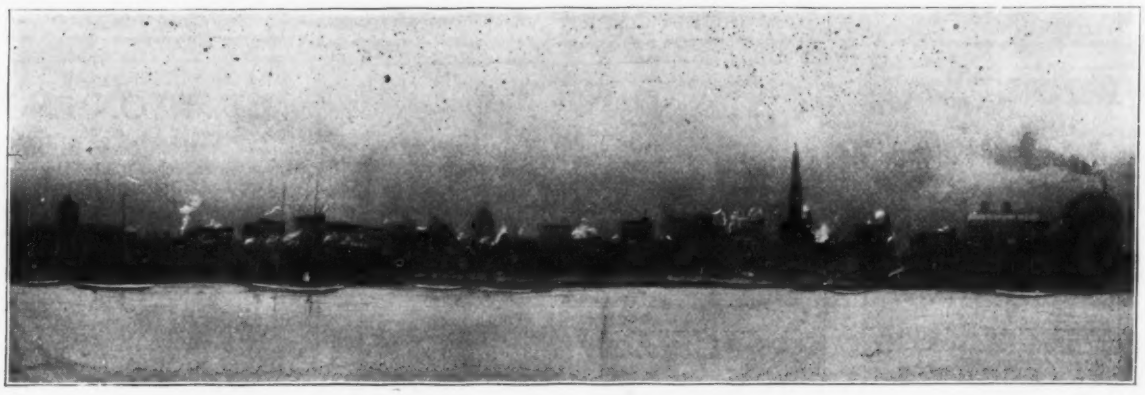

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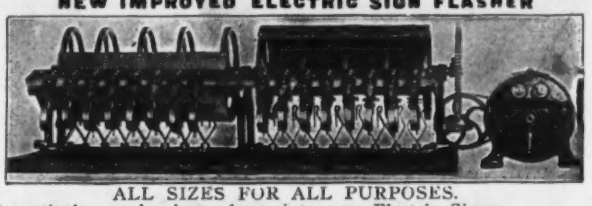

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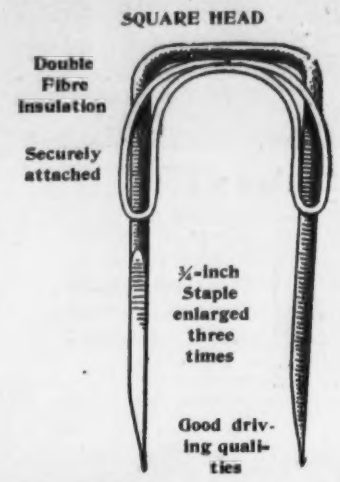

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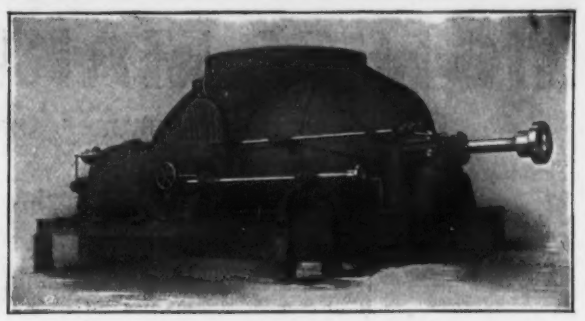

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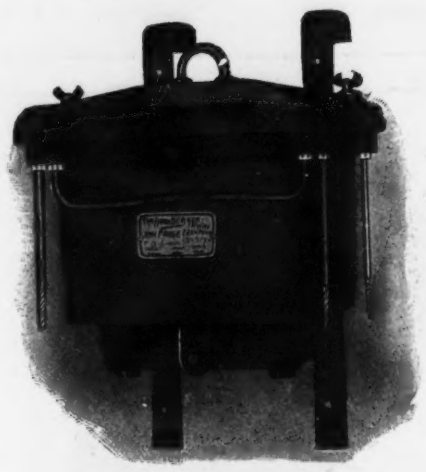

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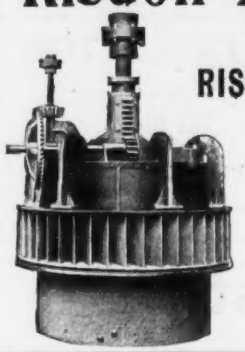

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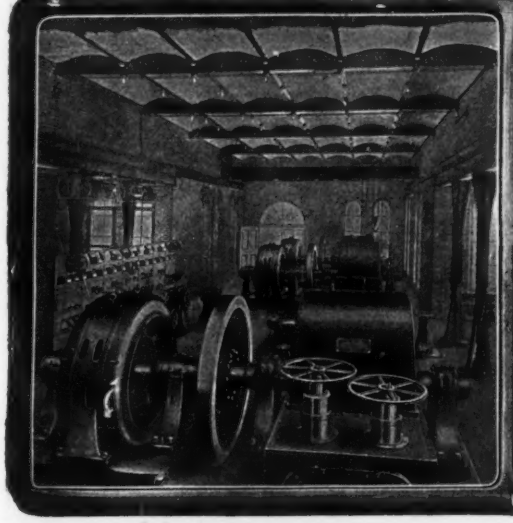

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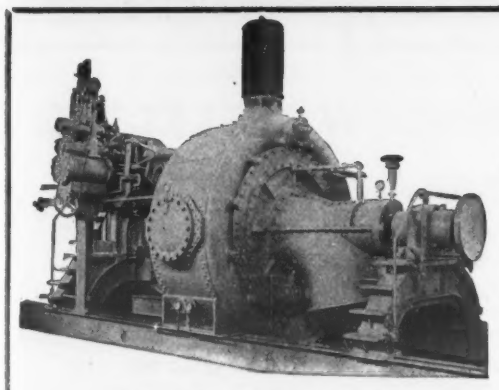

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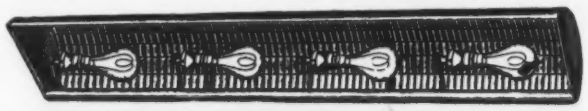

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